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ABSTRACT

This guide was prepared to assist in determining the mathematics that should be included in drafting, electricity, electronics, and machine shop programs. Information for the guide was obtained by asking teachers from every postsecondary vocational school in Kentucky to respond to a questionnaire listing mathematics competencies for their specialty by marking each competency as "needed" or "not needed." The guide is organized in four sections. The first section provides a background for understanding and using the handbook information. The "how" and "why" of what was done are explained in this section. The second section deals with the mathematics competencies for the four programs. Listed are common competencies, competencies specific to programs, and information on using the competency information. Since it may be difficult to visualize a mathematics competency, the third section gives two examples for each mathematics competency selected by the instructors. The fourth section contains resource information provided by the vocational educators. The appendixes include: (1) a list of participants; (2) the survey forms; (3) survey responses; (4) competencies not selected by instructors; and (5) additional competencies submitted by instructors. (KC)

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Exit Math Competencies for Selected Industrial Education Post - Secondary Programs in Kentucky

(Drafting, Electricity, Electronics, Machine Shop)

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June 30, 1987

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The first thought that comes to mind relates to the instructors. We realized it was asking a lot from this busy group of professionals to complete the lengthy surveys. However, the majority of instructors responded with good information. Our sincere thanks and admiration goes to these instructors.

This project could not have been completed without the assistance of the vocational school principals and counselors. They identifyed instructors, followed up our requests to complete and return surveys, and showed remarkable patience when we contacted them a number of times to be sure activities were going as planned.

Our planning committee helped us get a good start and their enthusiasm helped us to gain momentum as the project evolved. Many times during the project we looked back at what the committee decided to be sure everything was going as planned. We deeply appreciate the committee's efforts.

The Office of Vocational Education provided essential support when needed. Gary Hess was always available for help and gave timely support throughout the project. Lou Perry, Bill Whalen, and many others always shared their busy schedules to help us solve our project problems.

As project director, my sincere thanks goes to Barbara Sworin and Susan Brown. They took responsibilty for activities and completed them in a quality manner. They share in the success of the project.

Forward

This report was intended to be used to assist in determining the math that should be included in drafting, electricity, electronics, and machine shop programs. Information for the report was obtained by asking teachers from every post-secondary vocational school in Kentucky to provide input.

The first section provided a background for understanding and using the handbook information. The "how" and "why" of what was done are explained. This section should be carefully perused to be able to make application of other sections.

The second section deals with the math competencies for the four programs. This section should be of great interest to instructors as they strive to decide what math should and should not be taught.

It may be difficult to visualize a math competency. The third section gives 2 examples for each math competency selected by instructors. This allows one to review examples so the competency definition is clear.

The fourth section presents resource information provided by the vocational instructors.

The Appendices has a variety of information that may be as useful as that found in the handbook sections. This information fills in the gaps for making decisions about the teaching of math in selected vocational programs.

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Section 1

Background

High technology is bringing about numerous changes in the workplace. New goods and services are being introduced, established products are phasing out, and processes that have been the basis for production are changing. As a result, many new industries are being introduced while other industries are either upgrading to meet the challenges or going out of business.

Changes in business and industry are having a significant effect on employment. Between 1984 and 1995, the Bureau of Labor Statistics estimates that over 15 million jobs will be available. Many of these jobs will be new with job descriptions that focus on high technology where computers, electronics, automation, robots, and other related systems are integral parts of job performance. Other available jobs are those that have been established over the years, but will require new skills and knowledge to meet job requirements.

Persons applying for these positions will be expected to have certain sets of competencies that enhance working with new industrial innovations. Training will be supplied by employers, but the training will focus on adapting skills workers already have to high technology skills needed to succeed at work. This will require new workers to have strong and diverse backgrounds in practices and principles of their occupational areas, as well as good math backgrounds that

occupational areas, as well as good math backgrounds that allow applications to a variety of technical problems.

Another factor affecting workers is the everchanging nature of business and industry. Workers will always be faced with the possibility of job obsolescence and displacement. Workers can expect to change occupations several times and jobs up to 10 or so times during a career. Workers must be prepared for this and be able to adapt quickly and effectively to meet new job requirements. As jobs become more technical it will be most important for workers to stay current in their occupational areas along with building expertise in skills and knowledges that allow transfer to other related positions. The application of scientific principles through problem solving and math appears to be necessary to make transitions to the available jobs of tommorow.

The shift in the future is to employment in small businesses. This trend affects the educational preperation of perspective workers because small businesses cannot provide extensive training. Workers entering these small businesses must have relevant and diverse skills and knowledges that allow for direct applications to job responsibilities. They will have to have the training background to deal with many practices and principles of their occupational areas and be able to make quick and efficient applications that are required by the new positions.

It is difficult to predict the exact skills and knowledges that are needed by perspective worker to succeed in the everchanging world of business and industry. However, some assumptions can be made. The move toward high technology requires workers to have more knowledge in principles and practices underlying occupational competence. This must be combined with the ability to make application of the information to problem solve, troubleshoot, adapt to new situations and modify what is known to apply to technical innovations. Workers must be more thoroughly trained in their occupational specialties and be adept at math skills that allow flexibility and efficiency in coping with new situations in the workplace.

Education

Education is a mirror of society. As changes in business and industry make it more difficult for persons to succeed at work, society gives more input into public schools to effect change. Both general and vocational education have reacted to the pressure by making many changes. This will continue into the future and will challenge educators to meet change with change to prepare people to make efficient transitions from training to the world of work.

General education has made many significant changes to be sure students are math literate. More math is required than in the past to graduate from high school, there are fewer electives that students can select, and more math options are available to meet the diverse needs of the

student population. Along with this there seems to be greater attention to ensuring students have appropriate skills before allowing them to progress to other experiences or passing to higher grade levels. At the conclusion of high school, students must pass a competency test to demonstrate their abilities to display and use math skills.

Post-secondary vocational education is also focusing more on math as an important part of vocational training. All incoming students must demonstrate competency through testing in the basics, including math. There are support strategies for helping students learn math in vocational courses and remedial programs are available to help those that are deficient in math. There are continuous efforts in the schools to determine the math students should have when enrolled and instructors are continuously striving to teach the math necessary for successful employment.

Math competencies

The Test of Adult Basic Education (T.A.B.E.) is used in all state vocational technical schools in Kentucky to measure the basic math competencies of entering adult students. The test results are expressed by grade levels and students must attain at least a 10th grade level to satisfy part of enrollment requirements. The T.A.B.E. measuring instrument was used in the project as a reference for definition. The "basic math competencies" were defined as those competencies in math that are listed in the T.A.B.E.

Vocational education focuses mainly on applications of

basic math to a variety of occupational situations. As students progress, more difficult applications require more difficult equations and problem solving. Students learn to identify where, when, and how to apply various basic math specific to succeeding in occupations.

At some point in vocational training, math competencies become more advanced than basic competencies. Instructors teach this math as they would any other course content. In some cases a seperate math book is used as reference. At other times, the math competency is integrated with occupational content and is learned through a variety of teaching techniques. The challenge for the instructors is to determine the more advanced math competencies and decide on the degree of emphasis in instruction.

The more advanced math competencies vocational instructors select for teaching are arrived at by analyzing what workers do on the job . Thus, they might be described as math competencies necessary to succeed on the job. For the purpose of this project, these competencies will be called "exit math competencies", that is, those competencies students should have upon graduation from a vocational program so they are prepared to enter jobs for which they are trained.

One of the problems in trying to identify math competencies in vocational programs is that math content and occupational content are often linked so it is difficult to seperate one from another. For this handbook, attempts were

made to make math competencies non-occupational and general. However, in some cases this was not possible and resulted in listings that are both occupational and non-occupational related.

Every vocational course has a different set of required math competencies. If courses were placed on a continuum from technical to non-technical, each course would fit somewhere on that continuum. A number of courses would tend to group around the technical end of the comtinuum and would require a large number of math competencies while a number of courses would be grouped near the other end and would require fewer math competencies. Other courses would fit somewhere in between. For the purpose of this handbook, the 4 programs of electronics, electricity, drafting, and machine shop were selected. These courses would fit somewhere near the technical end of the continuum and have a significant number of exit math competencies. Also, since the courses are very technical in nature there were a number of exit math competencies that were "common" to the 4 selected programs.

Decision making

Early in the project it was recognized that assistance was needed to be sure decision making was appropriate. An advisory committee was formed to help steer the project in the right direction. The committee members were selected to be representative of groups that were very concerned with the teaching of exit math competencies. A meeting was scheduled in October and a number of decisions were made tha

formed the basis for program direction. Materials related to advisory committee functioning can be examined in Appendix 1.

Instructors were selected to determine the competencies that should be included in vocational programs. The reasoning for the decision was that instructors can be considered an extension of business and industry. They meet, greet, and relate with workers and managers of business and industry on a continuing basis. They are also involved with staff-industry exchange experiences and many contiuue working in their occupational areas during off times from teaching.

A mumber of post-secondary vocational programs have more than one course in the program and a day and night program. This caused some concern as to who should be asked to give information about needed competencies. The decision was made to select one day instructor and, if applicable one night instructor in each school. A guidance counselor in each of the 14 post-secondary schools provided names of instructors who should receive the survey. See Appendix 2 for names of the selected instructors.

The survey

A survey form for each selected program was developed to establish exit math competencies. Math resources for the 4 post-secondary vocational programs were determined by using an information sheet. See Appendix 3 for the surveys and information sheet.

The first step in developing the survey was to seek information about exit math competencies. This started with

a literature search and review of various materials such as a a computerized eric search and numerous materials provided by the Office of Vocational Education, Frankfort, Kentucky. There was a paucity of information that related to "exit math competencies." There was a significant amount of information about "basic math competencies."

Because of the limited information the decision was made to conduct an occupational analysis for the purpose of identifying exit math competencies. A number of textbooks were selected as representative of the math content for the 4 programs (see Section 4 for a listing of textbooks). For each program textbooks were analyzed and a list of math competencies was compiled. In some instances math competencies were easily identifyed and taken directly from the textbook, In other instances, tasks were analyzed to determine what math skills were needed to successfully complete the tasks. The resulting 4 lists of math competencies were then sorted by whether they were basic or exit math competencies. The list of basic math competencies was discarded. Exit math competencies were ordered according to difficulty (simple to complex) and in certain instances were grouped by activies (such as graphing). The resulting lists were used for developing the surveys.

Collecting information

A survey was mailed to each of the instructors. They were asked to examine their curriculum and teaching materials to respond to the survey as accurately as possible. Also,

instructors were asked to share the survey with other co-workers so the decisions about competencies would be program oriented. Instructors were asked to return the survey in two weeks.

There were several follow-ups to the survey. Instructors were contacted by phone several times; principals were mailed materials, and; copies of the survey were mailed to many in second mailings. These procedures resulted in a 95% return rate. The numbers of instructors responding from each program can be noted from the N (number responding) in Table 1-5, Section 2.

Section Two

Exit Math Competencies for Selected Vocational Programs

Instructors from the post-secondary vocational programs of drafting, electricity, electronics and machine shop were asked to identify exit math competencies. The explaination to the instructors was:

> The purpose of the project is to identify the math skills needed upon graduation from a post-secondary program to gain meaningful employment in the occupation for which trained. The project is designed to determine the technical math skills needed in (program name) above and beyond the math skills identified on the T.A.B.E. test.

The assumption was made that students met entry level requirements for the selected program, therefore only new competencies to be acquired during instruction needed to be listed. These competencies should represent the exit math skills necessary to perform entry level job related tasks upon graduation from the selected program.

The decision had to be made as to how competencies should be selected as necessary for the vocational training programs. The adopted decision rule for this handbook was: A competency was selected as needed for a vocational training program if the competency was indicated as necessary by at least 80% of the instructors responding to the survey. This section listed the competencies selected by instructors.

The tabulations of survey responses can be found in Appendix 4. Competencies not selected were listed in Appendix 5.

Every competency in each of the 4 surveys was assigned a number. All of the information about specific competencies in the sections and appendices were referenced to these numbers. Thus, a specific competency can be identifyed from a survey and tables 1-5 and appendix 5 used to determine whether or not the competency was selected or not selected.

Also, examples in Section 3 were referenced to the competency numbers so competencies selected by instructors can be defined.

Instructors were given the opportunity to provide other competencies to supplement information from the survey. These competencies were listed in Appendix 6.

Common competencies

As instructors from the 14 post-secondary vocational schools responded to the survey and the results were analyzed, it was apparent that a number of competencies were common to all of the programs. Table 1 listed these competencies. They are non-occupationally specific, that is the competencies were stated without reference to occupations. This does not mean they were used in this form in any of the programs. In a training situation, the competencies may be used as stated, combined with occupational information and/or used with several other competencies to arrive at appropriate solutions to problems.

Competencies specific to programs

Tables 2,4,5 displayed competencies selected by instructors for the programs of drafting, electronics, and machine shop. Instructors from these programs selected a number of the competencies listed in the surveys.

To determine electricity competencies the electronics survey was used. This was done because there seemed to be many similar competencies for the 2 programs. Yet, there were disagreements about the appropriateness of the competencies on the survey. Few competencies were selected in comparison to the other programs (see Table 3), and few additional competencies were submitted (see Appendix 6).

Discussion

Asking instructors to identify exit math competencies as differentiated from basic math competencies needs to be discussed. First, instructors must be familiar with the T.A.B.E. and be able to categorize competencies as either basic or exit competencies. This could mean that some of the competencies rejected by instructors were needed in the programs, but were considered basic to entering the programs. This should not happen often as the decision rule for how competencies were selected allows for some error in the recognition of competencies (i.e. 2 out of 10 instructors can reject a competency and the competency will appear on the list as needed in a program).

Furthermore, what will the list of accepted competencies represent? From instructors viewpoints, the

survey represents math competencies students need to be prepared for employment in the local area, the state and in other geographic areas. Additionally, competencies could be selected that are needed by workers to receive promotion or to be able to profit from further education. Thus, competencies needed at the local level according to one instructor may not show up on the list because others did not see the need for and did not select the competencies. The math competency list in this handbook will most acurately represent a portion of the math competencies needed in all programs to succeed at employment.

Using the competency information

The above discussion indicates that the competency lists in this handbook must be used carefully. The competencies needed in a vocational program are the total of the basic and exit math competencies needed for employment. The total of these competencies include competencies generally needed to succeed in a particular occupation over a large geographic area and those competencies needed to succeed at specific jobs in local areas served by training programs. Also, additional competencies may be needed to meet student needs, educational aspirations, promotional possibilities, and career mobility. Each like vocational training progam may have different math competencies because of particular local situations. The instructors' challenge is to determine when and how to use the information in this handbook to improve program offerings.

The following suggestions are made when using this handbook:

(1) Compare the math competencies being taught in a program with those competencies listed in Section 2. If a competency is not being taught that is listed, the "why" it is not being taught should be addressed. If the competency is taught, this is in line with what other instructors in Kentucky are teaching. The examples in Section 3 will be helpful to define particular competencies.

(2) Compare the math competencies being taught in a program with the rejected competencies listed in Appendix 5. If a rejected competency is taught in a program because it is basic to understanding course material, the competency should continue to be addressed in instruction. However, if the competency is more advanced than a basic competency, the "why" the competency is taught should be analyzed. If the rejected competencies are not taught, this is in congruence with what other instructors in Kentucky are teaching.

(3) If there are additional competencies that are not on any of the lists in the handbook, yet they are taught in the program, an evaluation of "why" they are being taught should be undertaken. Additional competencies may be needed to deal with local situations.

(4) The information in this handbook has implications for programs, students, business and industry. Therefore, any possible changes due to comparisons of what is being done to what is needed according to handbook information should be

shared with others. A suggestion is made to share the resulting information with advisory committee members, relevant business and industry personnel, and other instructors from similar programs. This could help to make more in-depth analysis of the "whys" for teaching competencies and may help in arriving at equitable solutions.
(5) The resource lists can be observed to determine possible resources for teaching exit math competencies. Section 4 will be helpful in this endeavor.
(6) The examples in Section 3 can assist in defining the competencies. Also, they may be used in lessons, for evaluation, and for explaining course requirements and progress to those not familiar with the occupational area.

The suggestions for using this handbook do not cover all situations encountered in planning, implementing, and evaluating vocational programs. The information in the handbook suggests that there will be manuy uses for the information when discussions evolve around math competencies and resources for the 4 programs. The use of this handbook is limited only by the creativity and intents of the user.

Table 1

Common Exit Math Competencies for the Vocational Programs of Drafting, Electricity, Electronics, Machine Shop (N = 50)

---

1. Add, subract, multiply, and divide on a number line.
2. Represent the products of two numbers on a graph.
3. Find the value of a radius vector graphically.
5. Determine x and y intercepts on a number line.
7. Convert a whole number to a positive power of ten.
9. Square a number.
10. Find the square root of a number.
24. Group common terms in an equation.
26. Solve equations with one unknown.
27. Solve equations by transposing.
28. Solve an equation by canceling a term.
29. Check solutions to equations.
30. Form equations from observed data.
45. Determine complimentary and supplementary angles of a triangle.
46. Find the arc, sine, cosine, and tangent of an angle.
47. Find functions of angles greater than 90.
48. Find functions of angles in second, third and fourth quadrants.
49. Solve a problem involving similar right triangles.
50. Find trigometric ratios of angles of right triangles.
51. Solve for angle, sides, and hypotenuse for a right triangle.
53. Solve word problems related to a right triangle.
58. Convert a fraction to a decimal.

Table 2

Math Competencies for Drafting (N = 12)

---

17. Multiply and divide numbers with exponents.
31. Solve a problem using a formula with knowns and one unknown expressed in the same unit.
32. Solve a problem unvolving 2 formulas, 3 or more knowns, and one unknown.
55. Reduce a fraction to its lowest term.
57. Add, subtract, multiply and divide fractions.
77. Find the correct proportions of selected objects.
78. Determine dimensions to scale.

Define the following :

79.Parts of a circle.
80.Concentric circles.
81.Eccentric circles.
82.Right angle.
83.Acute angle.
84.Obtuse angle.
85.Complementary angle.
86. Supplementary angles.

87. Calculate the area and circumference of a circle.

List the side and or angle relationships for the following:

88. Equilateral triangle.
89. Isosceles triangle.
90. Scalene triangle.
91. Right triangle.
92. Right triangle in a semi-circle.
93. Square.
94. Rectangle.
95. Rhombus.
96. Rhomboid.
97. Trapezoid.
98. Trapezium.
99. Pentagon.
100. Hexagon.
101. Heptagon.
102. Octagon.
111. Right square.
112. Oblique triangle.

List elements for the following:

118. Right circular cylinder.

127. Divide lines into equal divisions.
128. Determine the measurements of elarged and reduced objects.
129. Determine the tolerances and limits of drill holes.
130. Determine clearance, transition, and interference fits.
131. Determine dimensions and tolerances of an internal and an external cylindrical surface.
132. Compute horizontal and vertical spacing of an object.

133. Construct a bar graph.
134. Describe information from a line graph.
135. Construct a circle graph and pie chart.
136. Compute diametral pitch of a thread.
137. Compute circular pitch of a thread.
138. Compute vertical spacing, given the working space and height of an object.
139. Compute diametral pitch of a gear.
140. Compute circular pitch diameter of a gear.
141. Compute pitch diameter of a gear.
142. Compute outside diameter of a gear.
143. Compute root diameter of a gear.
144. Compute addendum of a gear.
145. Compute dedendum of a gear.
146. Calculate whole depth using a formula.
147. Compute circular thickness of a gear.
148. Determine metric numbers that represent the SI prefix symbols.
149. Determine metric prefix names for prefix symbols.
150. Find the equivalent value in metrics of a value with a prefix symbol.
151. Determine customary lengths for selected metric lengths.
152. Convert units in the metric system.
153. Convert lengths from English to metric.
154. Calculate areas of objects in the metric system.
155. Convert lengths from metric to English.
156. Convert dimensions of objects from English to metric.
157. Convert areas measurements to metric areas.
158. Compute metric volumes.
159. Convert customary dimensions to metric dimensions and calculate the volume in metric units.

Find the correct drafting scale ratio in metrics for:

160. Assembly drawings.
161. Detail drawings.
162. Working drawings.
163. Site plans.
164. Surveys.
165. Maps.

Table 3

Math Competencies for Electricity (N = 12)

13.	Take the square root of a monomial.
31.	Solve a problem using a formula with knowns and one unknown.
37.	Factor a simple equation.
91.	Find the magnitude and direction of vectors.
92.	Find the horizontal and vertical components of vectors.
93.	Find the resultant forces of vectors.
97.	Write equations for voltage and current using an AC circuit.
98.	Draw vector diagrams of circuits, and construct vectors for AC circuits.
110.	Express numbers in the binary number system.

Table 4

Math Competencies for Electronics (N = 13)

---

4. Represent trigometric functions by graphing.
6. Solve two simultaneous equations by graphing.
8. Add, subtract, multiply and divide positive and negative powers of ten.
11. Square a monomial.
13. Take the square root of a monomial.
15. Square a binomial.
17. Multiply and divide numbers with exponents.
18. Multiply a number with an exponent by an exponent.
19. Multiply a fraction with an exponent by an exponent.
20. Express numbers with negative exponents as numbers with positive exponents.
21. Find the values of numbers with fractional exponents.
22. Simplify radicals containing fractions.
25. Determine signs in a complex equation.
31. Solve a problem using a formula with knowns and one unknown expressed in the same unit.
32. Solve a problem involving 2 formulas, 3 or more knowns, and one unknown.
33. Solve a problem involving 3 formulas, 3 or more knowns, and one or more unknown.
34. Solve a quadradic equation.
35. Solve equations with the quadradic formula.
37. Factor a simple equation.
38. Find the prime factors of equations.
39. Find the product with the difference and sum of two equations.
41. Solve simultaneous linear equations by addition and subtraction.
42. Solve simultaneous linear equations by substitution.
43. Solve simultaneous equations by comparison.
44. Solve fractional form simultaneous equations.
52. Solve graphically for elements of a right triangle.
54. Find the least common multiple.
55. Reduce a fraction to its lowest term.
56. Change the sign of fractions.
57. Add, subtract, multiply and divide fractions.
59. Set up equations from theory.
60. Express equations in logarithmic form.
61. Find the logarithm of a product.
62. Find the logarithm of a quotient.
63. Find the logarithm of a power.
64. Find the logarithm of a root.
65. Find the logarithm of a number.
66. Express equations in exponential form.
67. Find the antilog of a number.
68. Add logarithms.
69. Subtract logarithms.
70. Multiply logarithms.

72. Division by logarithms.
73. Multiplication and division by logarithms.
78. Solve electronic problems using logarithms.
79. Express gain or loss of apparatus in decibels.
80. Express gain or loss of quantities in decibels. (logarithms).
84. Graph the equation.
85. Graph the cosine curve.
86. In equations of periodic curves, specify frequency.
87. In equations of periodic curves, specify angle of velocity.
88. In equations of periodic curve, specify the amplitude.
89. In equations of periodic curve, specify period.
90. In equations of periodic curve, specify angle of lead or lag.
91. Find the magnitude and direction of vectors.
92. Find the horizontal and vertical components of vectors.
93. Find the resultant forces of vectors.
94. Use vector diagrams to find instantaneous values in an AC circuit.
95. Determine angles in a vector diagram of an AC circuit.
96. Find the angular velocity of an AC circuit.
97. Write equations for voltage and current using an AC circuit.
98. Draw vector diagrams of circuits and construct vectors for AC circuits.
99. Determine angles in a vector diagram and plot imaginary numbers on a vector diagram.
100. Express AC circuit parameters in polar form.
101. Convert AC circuit parameters from rectangular to polar form and vice versa.
102. Solve problems using parameters expressed in rectangular form.
103. Solve problems using parameters expressed in polar form.
104. Add vectors in rectangular form.
105. Subtract vectors in rectangular form.
106. Multiply vectors in rectangular form.
107. Divide vectors in rectangular form.
108. Multiply polar vectors.
109. Divide polar vectors.
110. Express numbers in the binary number system.
111. Construct and analyze truth tables.
112. Develop a Boolean equation from a logic diagram.
113. Use the sum of products method to solve a Boolean equation.
114. Develop a sum-of-products equation from a truth table.
115. Simplify a Boolean equation.
116. Convert a truth table into a Karnough map.
117. Draw a three and four variable Karnough map from a truth table.
118. Simplify a Karnough map by using octets, quads, or pairs.
119. Use the product of sums method to simplify a truth table.

120. Convert a truth table to an equation.
121. Simplify a product of sums equation.
122. Use multiplexer logic.
123. Find BCD equivalents of decimal numbers.
124. Convert binary numbers to decimal equivalents.
125. Convert octal numbers to decimal equivalents.
126. Find the decimal equivalents of an octal number.
127. Convert hexadecimal numbers to binary numbers.
128. Convert octal numbers to decimal equivalents.
129. Find the decimal equivalent of an octal number.
130. Convert hexadecimal numbers to binary numbers.
131. Express a decimal number in Excess - 3 code.
132. Express an Excess - 3 number as a decimal equivalent.
133. Convert Gray numbers to a decimal equivalent.
134. Give the sum of numbers in base 8 of 16.
135. Sum of binary numbers.
136. Add whole numbers in base 10 using 16 bit numbers.
137. Subtract binary numbers.
138. Subtract whole numbers in the base ten system.
139. Determine overflow of problems with 8 bit unsigned arithmetic.
140. Express positive or negative whole numbers in 8 bit sign magnitude form.
141. Convert sign magnitude numbers into decimal equivalents.
142. Express the complement of numbers in hexadecimal notation.
143. Express the 2's complement of binary numbers.
144. Convert positive or negative whole numbers to 2's complement representation.
145. Show the 8 bit addition and subtraction of decimal numbers in 2's complement representation.

Table 5

Math Competencies for Machine Shop (N =11)

78. Convert from English units to metric units and visa versa.
79. Determine tolerance for a measurement.
80. Find the circumference for a circle.
81. Find the perimeter of any polygon.
82. Find the area of a circle.
83. Find the pitch of a screw.
84. Find the cutting speed, given the revolutions of lathe per minute, and the diameter.
85. Solve problems using percentages.
86. Read a micrometer.
87. Read a vernier caliper.
88. Read a vernier protractor.
89. Subtract with degrees, minutes, and seconds.
90. Find decimal equivalents of minutes and seconds.
91. Find minute and second equivalents of decimals.
92. Determine sizes of angles on drawings.
93. Find the area of a circle, triangle, square, parallelogram and rectangle.
94. Find the diagonal of a square.
95. Find the distance across the flats or corners in a hexagon.
96. Use a table of natural functions to find a function of of an angle.
97. Interpolate to find values of angle functions for minutes.
98. Use the Law of Sines to solve an oblique triangle.
99. Use the Law of Cosines to solve an oblique triangle.
100. Determine the amount of taper.
101. Determine the amount of offset needed to produce a given taper.
102. Convert taper measurements to angle measurements.
103. Determine the amount of error in a given taper.
104. Use a general speed formula for two gears in mesh to solve problems.
105. Solve problems involving simple and compound gear trains.
106. Solve problems involving worm gearing.
107. Find the rpm of a tool, knowing the cutting speed and diameter.
108. Calculate drill speeds.
109. Find the rate of feed for lathe tools.
110. Determine a cutting time for lathe and milling operations
111. Find the pitch of a thread.
112. Measure a screw thread.
113. Determine outside diameters and tap drill sizes for machine screws.

114. Find the outside diameter of a gear, knowing the number of teeth and diametrical pitch.
115. Find the center to center distance for two meshing spur gears.
116. Design a gear train.
117. Use continued fractions to convert speed ratio's into gear combinations.
118. Convert metric module to diametrical pitch.
119. Determine the number of turns on a dividing head for indexing.
120. Index for degrees, minutes, and seconds.

Section 3

Examples of Exit Math Competencies

In order for the competencies listed in the surveys to be meaningful it was necessary to create examples. The examples were designed to be as non-occupational as possible to enhance explaination and demonstration of the math competencies. Textbooks in the four areas (electronics, electricity, drafting, machine shop) were used to develop some examples, while the more general examples were developed independently. Applications of the competencies used in instruction were probably more occupationally specific.

To develop examples a list was made of math competencies selected by instructors that were common to the 4 programs. Twenty two math competencies were identified. Two examples were developed for each competency and listed in Table 6. Table 7-10 displays examples specific to the 4 program areas.

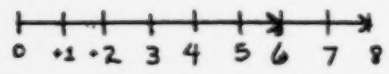
The purpose of the examples in the tables was to provide useful information about exit math competencies to those interested in and/or associated with the 4 training programs. The teacher and student can review the examples to determine if competency has been achieved during instruction. The examples can also serve as an outline for developing problems and tests that will enhance competency attainment in the occupational program. Finally, the examples can be used by advisory committees, parents, students and counselors to describe math competencies required to exit the program of interest.

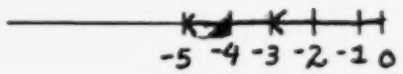
Table 6

EXAMPLES FOR COMMON MATH COMPETENCIES

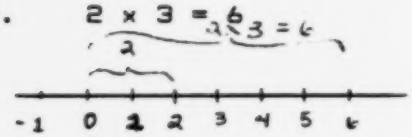
---

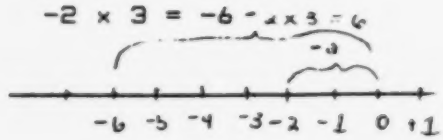
1. $6 - (-2) = 8$ $\qquad -3 - 2 = -5$



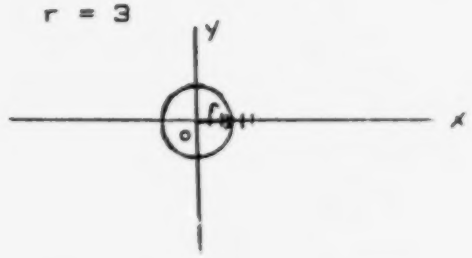


2. $2 \times 3 = 6$ $\qquad -2 \times 3 = -6$

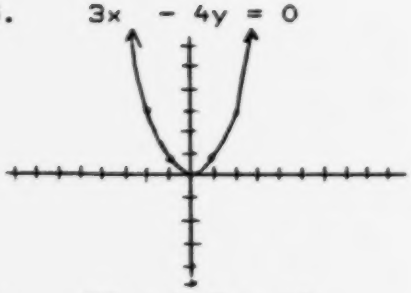


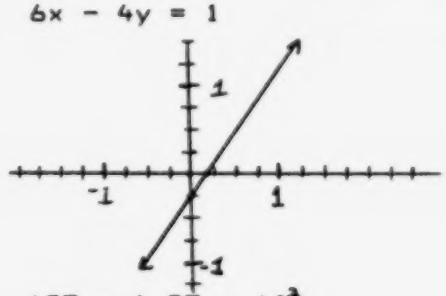


3. $r = 5$ $\qquad r = 3$



5. $3x - 4y = 0$ $\qquad 6x - 4y = 1$





7. $52 = 5.2 \times 10$ $\qquad 695 = 6.95 \times 10^{2}$

9. $4^{2} = 16$ $\qquad 25^{2} = 625$

10. $\sqrt{10} = 3.1623$ $\qquad \sqrt{40} = 6.3245$

24. $3x^{2} - 9xy^{2} = 3x(x - 3y^{2})$ $\qquad 2a - 6a^{2}b + 4ax - 10ay^{3} = 2a(1 - 3ab + 2x - 5y^{3})$

26. $2x = 1$, $x = 1/2$ $\qquad 4y = 2$, $y = 1/2$

27. $x + 5 = 10$, $x = 10 - 5$, $x = 5$ $\qquad 3i + 5 = 20$, $3i = 15$, $i = 15$

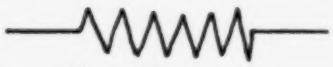
28. $x - z = 2 - z$
$x = 2$

$y + x = 14 + x$
$y = 14$

29. $4x + 3 = 15$
$x = 3$
Check:
$4(3) + 3 = 15$
$12 + 3 = 15$

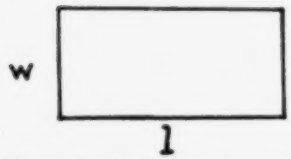
$9y + 6 = 24$
$y = 2$
Check:
$9(2) + 6 = 24$
$18 + 6 = 24$

30. $E = 30\ v$

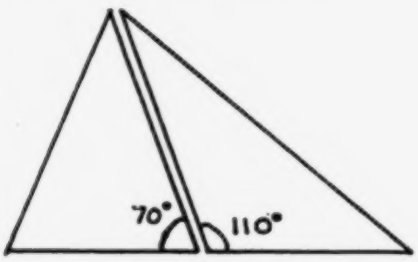


$R = 5$
$I = \frac{E}{R}$
Use $I = \frac{E}{R}$

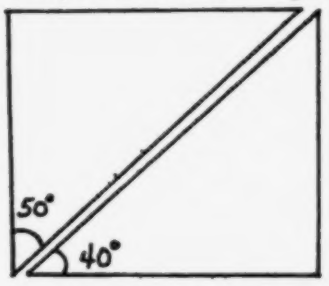
width = 4 length = 6
Find the perimeter
$P = (2l + 2w)$
$= 2(4 + 6) = 2(10) = 20$



45. Supplementary angles



Complementary angles



46. $\sin \theta = \frac{\text{opposite leg}}{\text{hypotenuse}}$
$\sin 30^\circ = .5$
$\sin 60^\circ = .866$

$\cos \theta = \frac{\text{adjacent side}}{\text{hypotenuse}}$
$\cos 30^\circ = .866$
$\cos 60^\circ = .5$

47. $\tan 175^\circ = -\tan (180^\circ - 175^\circ) = -\tan 5^\circ = -.0875$
$\tan 234^\circ = \tan (234^\circ - 180^\circ) = \tan 54^\circ = 1.3764$

48. Second quadrant:
$\sin 140^\circ = \sin (180^\circ - 140^\circ) = \sin 40^\circ = .6428$
$\cos 100^\circ = -\cos (180^\circ - 100^\circ) = -\cos 80^\circ = -.1736$

Third quadrant:
$\sin 200^\circ = -\sin (200^\circ - 180^\circ) = -\sin 20^\circ = -.3420$
$\cos 260^\circ = -\cos (260^\circ - 180^\circ) = -\cos 80^\circ = -.1736$

Fourth quadrant:
$\sin 300^\circ = -\sin (360^\circ - 300^\circ) = -\sin 60^\circ = -.8660$
$\cos 285^\circ = \cos (360^\circ - 285^\circ) = \cos 75^\circ = .2588$

49. $b = 3$ $c = 5$ $A = 53.1^\circ$ $a = ?$ $B = ?$ $C = ?$
$a = 4$ $B = 36.9^\circ$ $C = 90^\circ$

$a = 8$ $b = 5$ $C = 34^\circ$ $c = ?$ $A = ?$ $B = ?$

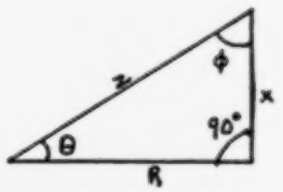
$c = 4.75 \quad A = 110^\circ \quad B = 36^\circ$

50. $\sin 26.44^\circ = .4452 \qquad \sin 13.6^\circ = .2351$
$\cos 88.1^\circ = .0332 \qquad \tan 48.8^\circ = 1.1423$

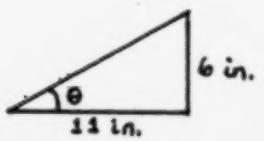
51. Given : $R = 30 \quad \theta = 25^\circ$ Solve for z, x, and ϕ

$\phi = 90^\circ - \theta$
$\phi = 65^\circ$
$\tan \theta = \frac{x}{R}$
$x = R \tan \theta$
$x = 30 \times .466 = 14$

$\sin \theta = \frac{x}{z}$
$z = \frac{x}{\sin \theta}$
$z = \frac{14}{.423}$
$z = 33.1$

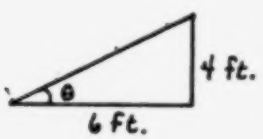


53. What is the angle of inclination of a stairway with the floor if the steps have a tread of 11 in. and a rise of 6 in. ?



$\tan \theta = \frac{x}{R}$
$\tan \theta = \frac{6}{11} = .545$
$\theta = 28.6$

What angle does a rafter make with the original horizontal if it has a rise of 4 ft. in a run of 6 ft ?



$\tan \theta = \frac{x}{R}$
$= \frac{4}{6} = .6667$
$\theta = 33.7$

58. $\frac{3}{2} = 1.5 \qquad \frac{697}{4181} = .1667$

Table 7

EXAMPLES FOR DRAFTING MATH COMPETENCIES (N = 12)

---

31. pitch diameter = 128 pitch diameter = 216
Sum of the two pitch diameter = 128 + 216 = 344
pitch cone angle = 45° addendum angle = 22.5°
face angle = pich cone angle + addendum angle
face angle = 45 + 22.5 = 67.5°

32. Mo = 6.15 N = 32
pitch diameter = N x Mo = 32 x 6.15 = 196.8 mm
OD = D + 2A = 196.8 + 2(6.15) = 209.1 mm
Mo = D/N CP = 3.1416 x Mo
D = 7.0 N = 12
Mo = 7.0/12 = .5833
CP = 3.1416 x .5833 = 1.8326

55. $\frac{14^{2} x^{3} y^{2} z}{7 x^{2} y} = 2xyz$ $\frac{64 x^{4} y^{3} z^{4}}{8 x^{2} y z^{3}} = 8 x^{2} y^{2}$

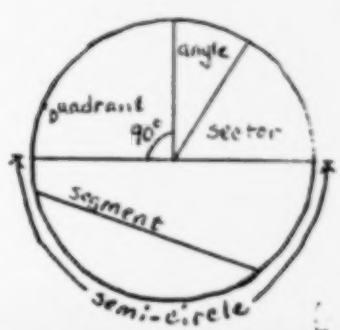
57. $\frac{e^{3}}{4} - 4 = \frac{e^{3} - 16}{4}$ $\frac{\frac{12x^{4}}{y^{3}}}{\frac{4x^{3}}{3y^{5}}} = \frac{9y^{2}}{x}$

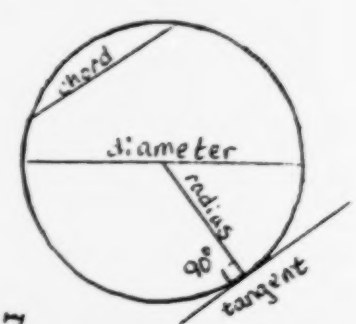
77. 4log x + 3.796 = 4.6990 + log x
4logx - log x = 4.6990 - 3.7960
3log x = .9030
log x = .3010
x = 2

$500 = 276 \log \frac{d}{.05}$
500 = 276 (log d - log .05)
1.81 = log d - log .05
log d = 1.81 + log .05
log d = 1.81 + 8.6990 - 10
log d = .5090
d = 3.23

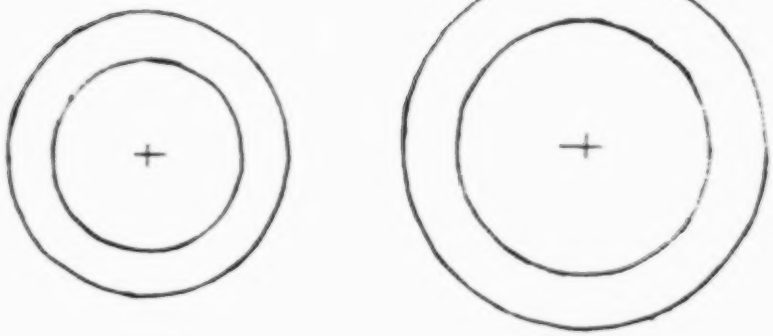
78. scale: full size (1/1) scale: half size (1/2)
5" = 5" 6" = 3"

79.

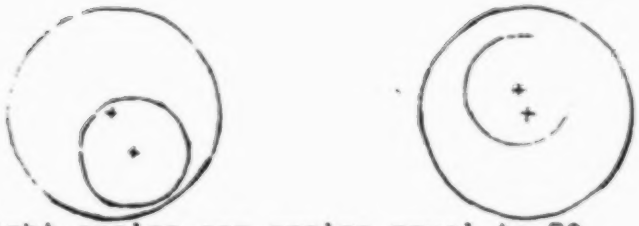




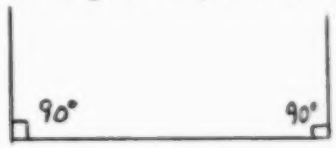
80.



81.



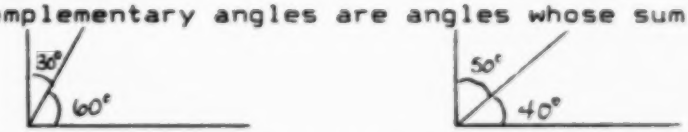
82. Right angles are angles equal to 90 .



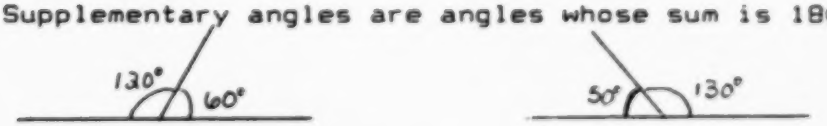
83. Acute angles are angles less than 90 .

84. Obtuse angles are angles that are more than 90 .

85. Complementary angles are angles whose sum equals 90 .



86. Supplementary angles are angles whose sum is 180 .



87. radius = 5 diameter = 10
circumference = 3.1416 x 10
= 31.416
radius = 7.5 diameter = 15

area = 3.1416 x r^2
= 3.1416 x 5^2
= 78.54
area = 3.1416 x r^2

circumference = 3.1416×15 = 47.124 $= 3.1416 \times 7.5^2$ = 176.715

88. Equilateral triangle : all sides and angles are equal.

89. Isosceles triangle : two sides are equal and base angles are equal.

90. Scalene triangle : one angle is obtuse.

91. Right angle : one angle is 90°.

92. hypotenuse = 1 diameter

93. Square : all sides are equal; all angles are 90 .

94. Rectangle : opposite sides are equal; all angles are 90 .

95. Rhombus : all sides are equal.

96. Rhomboid : adjacent sides are unequal.

97. Trapezoid : two sides are parallel.

98. Trapezium : no sides are parallel.

99. Pentagon : a polygon with five sides and five interior angles.

100. Hexagon : a six sided polygon.

101. Heptagon : a seven sided polygon.

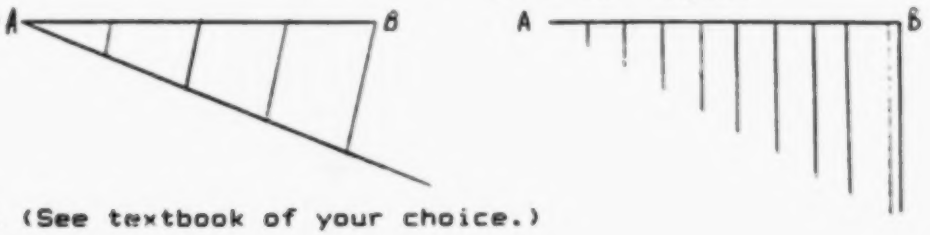
102. Octagon : an eight sided polygon.

111. Right square : all sides are equal, opposite sides are parallel, all angles 90°.

112. Oblique triangle : a triangle with no angles equal to 90°.

118. Right circular cylinder : two faces are circular with a curved surface and the axis at a 90° angle.

127.



128. (See textbook of your choice.)

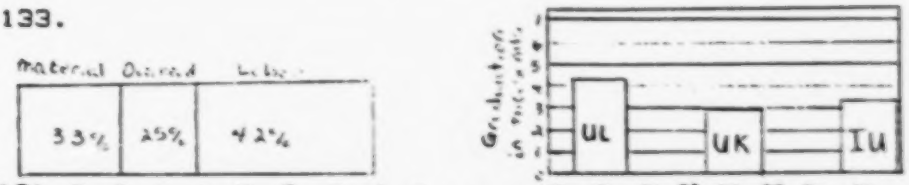
129. (See textbook of your choice.)

130. (See textbook of your choice.)

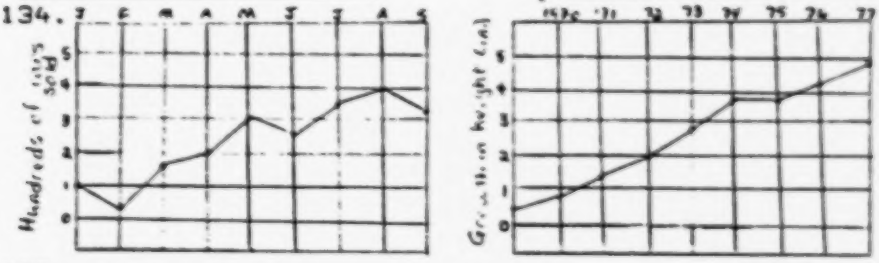
131. (See textbook of your choice.)

132. (See textbook of your choice.)

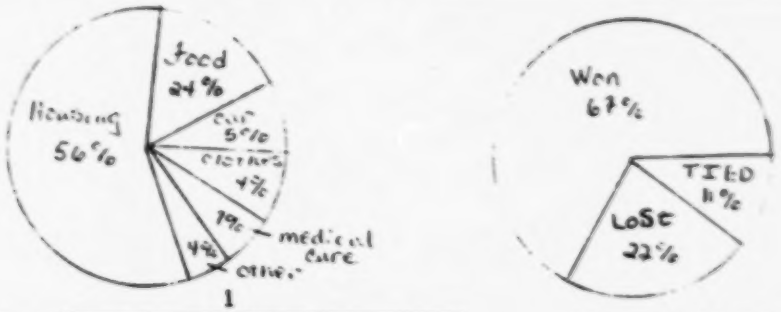
133.



134.



135.



136. $P = \frac{1}{\text{no. of threads per inch}}$

threads/inch = 32
P = 1/32

threads/inch = 40
P = 1/40

137. Circular pitch of a thread

P = 1/N N = 2 P = 1/2 = .5

N = 8 P = 1/8 = .125

138. (See textbook of your choice)

139. Diametral pitch of a gear

$P = \frac{N}{D}$ N = 48 D = 8 P = 6

N = 60 D = 10 P = 6

140.

$CP = \frac{3.1416\ D}{N}$ P = 4 CP = .7854

$CP = \frac{3.1416}{P}$ P = 5 CP = .6283

141. $D = \frac{N}{P}$ (inches)

N = 32 P = .125

$D = \frac{32}{.125}$

D = 256

D = Mo x N (metric)

N = 45 Mo = 7.35

D = 45 x 7.35

D = 330.75

142. OD = D + 2A = D + 2Mo

N = 36 P = 6

$OD = \frac{(36 + 2)}{6}$

OD = 6.33

N = 42 P = 4

$OD = \frac{(42 + 2)}{4}$

OD = 11

143. $RD = D - 2B = \frac{(N - 2.314)}{P}$

N = 72 P = 12

$RD = \frac{(72 - 2.314)}{12} = 5.8072$

N = 60 P = 10

$RD = \frac{(60 - 2.314)}{10} = 5.768$

144. Addendum

A = Mo = I/P

I = .8 P = .1122

A = .8/.1122 = 7.125

I = .8 Mo = 6.875

A = .8 x 6.875 = 5.5

145. B = Mo = I/P = 1.57 x Mo

Mo = 6.35

B = 1.157 x 6.35 = 7.347

Mo = 5.67

B = 1.157 x 5.67 = 6.561

146. WD = 2.157 x Mo

Mo = 6.331

WD = 2.157 x 6.331

WD = 13.656

WD = 1.8/P

P = 9.7

WD 1.8/9.7

WD = .1855

147. Circular Thickness

$T = \frac{3.1416\ D}{2N} = \frac{1.57}{P}$

N = 44 D = 4

$T = \frac{(3.1416 \times 4)}{2(44)}$

T = .1428

N = 24 P=6

$T = \frac{1.57}{6}$

T = .2617

148.

Prefix	Number
giga	1,000,000,000
hecto	100
deci	0.1
micro	0.000001

149.

Prefix Symbols	Prefix Names
G	giga
da	deka
μ	micro
n	nano

150. Mmeter = 1,000,000 meters

μgram = .000001 gram

151. one inch = 25.4 mm = 2.54 cm
one foot = 304.8 mm = 30.48 cm
one yard = 1.2144 m
one mile = 1.609 km

152. 1m = 10 dm = 100 cm = 1000 mm
$1dm^3 = 100\ cm^3 = 1$ litre = 1000 ml
$1dm^3$ of water = 1 kg

153. 100 miles = (1.609 x 100) = 160.9 km
32 yards = (1.2144 x 32) = 38.761

154. The sides of a square are all 100 m long. What is the area of the square?
Area = (100 x 100) m^2 = 10,000 m^2
The base of a triangle is 25 cm and its height is 10 cm. What is the area of the triangle?
Area = 1/2(25 cm x 10 cm) = 125 cm^2

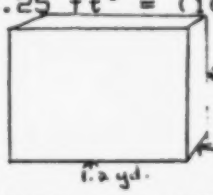
155. 64 km = (.621 x 64) miles = 39.74 miles
44 mm = (.039 x 44) inches = 1.716 inches

156. 2" x 4" = 50.8 x 101.6 mm = 5161.28 mm
10' x 10' = 304.8 x 304.8 cm = 92903.04 cm

157. 2.4 acres = 1 square hectometre (hectare)
52 acres = 20.8 hectares

158. 4.5 gallons = (3.785 x 4.5) litres = 17.0325 litres
$10.25\ ft^3$ = (10.25 x .028) m^3 = .287 m^3

159.



1.2 yds = (1.2 x 1.2144m)
= 1.4573 m
2 ft = .6667 yd
= (.6667 x 1.2144m)
= .8096

volume = (1.4573m)(1.4573m)(.8096m) = 1.7194 m^3
2.2 ft = 67.056 cm
volume = $(2.2ft)^3$ = $(67.056\ cm)^3$ = 301517.78 cm^3
= 301.5178 dm^3

160. millimeters 1:20 — inches 1:24

161. millimeters 1:5 — inches 1:4

162. millimeters 1:200 — inches 1:192

163. millimeters 1:1000 — inches 1:1250

164.	millimeters 1:2000	inches 1:2500
165.	millimeters 1:10,000	inches 1:10,560

Table 8

EXAMPLES FOR ELECTRICITY MATH COMPETENCIES (N = 12)

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13. $\sqrt{4a^2b^2} = 2ab$ $\sqrt{25a^2b^2} = 5ab$

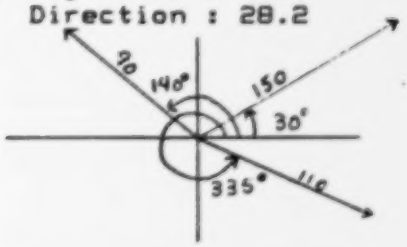
31. R_1, R_2, R_3, R_4 are in a series.
$R_1 = 10\,\Omega$ $R_2 = 20\,\Omega$ $R_3 = 30\,\Omega$
$R_1 + R_2 + R_3 + R_4 = 100\,\Omega$
$10 + 20 + 30 + R_4 = 100\,\Omega$
$R_4 = 40$

$E_1 = 50v$ $E_2 = 125v$ $E_3 = 75v$
$E_t = E_1 + E_2 + E_3 = 50 + 125 + 75 = 250v$

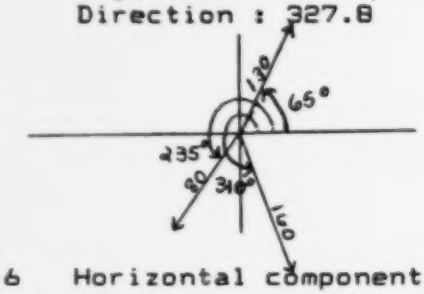
37. $3x + 3yx = 1$
$3x(1 + y) = 1$

$27b^2a + 3cba = 0$
$3ba(9b + c) = 0$

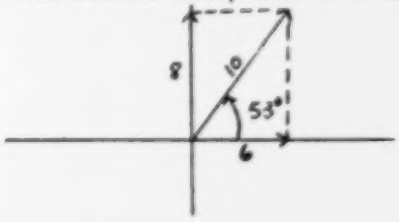
91. Magnitude : 182.5
Direction : 28.2



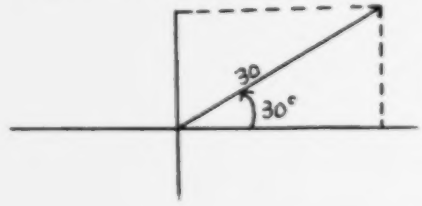
Magnitude : 132
Direction : 327.8



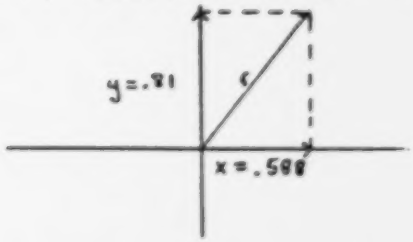
92. Horizontal component : 6
Vertical component : 8



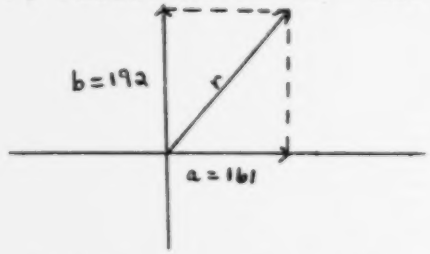
Horizontal component : 18
Vertical component : 24



93. r, resultant force = 1



r, resultant force = 250

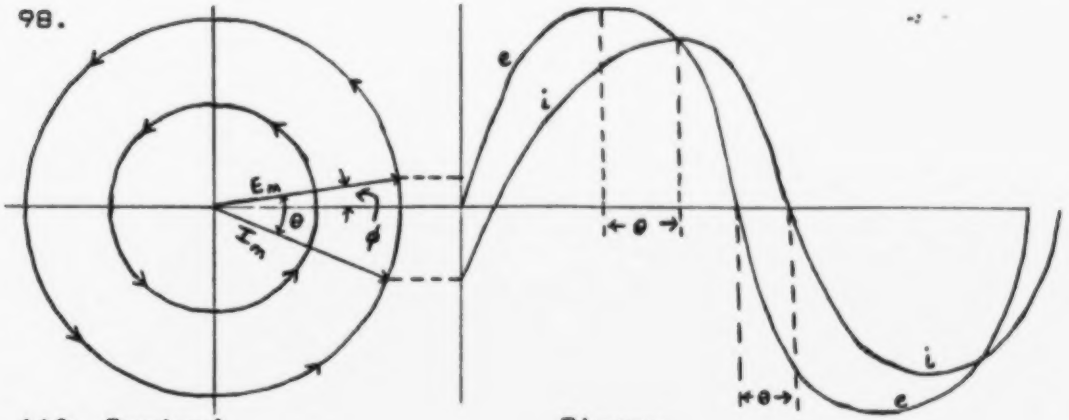


97. Maximum voltage : 170 v
Maximum current : 14.1 a
Frequency : 800
Phase angle : 40° lag
Voltage angle : 10°
e = 170 sin 5030t v

Maximum current : 14a
Maximum voltage : 220v
Phase angle : 60° lag
$E = 2E = 2 \times 220 = 311v$
$o = 245° + \theta = 245° + 60°$
$= 305° = -55°$

$i = 14.1 \sin (5030t - 40^\circ)a \quad e = 311 \sin (-55^\circ) = -255v$

98.



110. Decimal
4
15

Binary
0100
1111

Table 9

EXAMPLES FOR ELECTRONICS MATH COMPETENCIES (N = 13)

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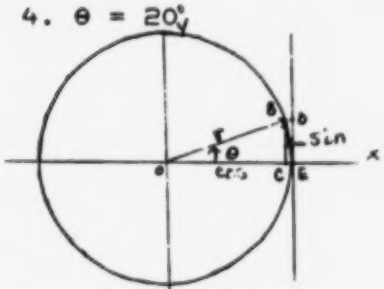
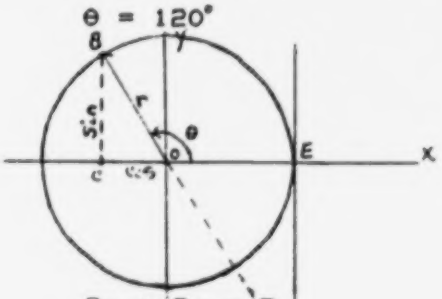
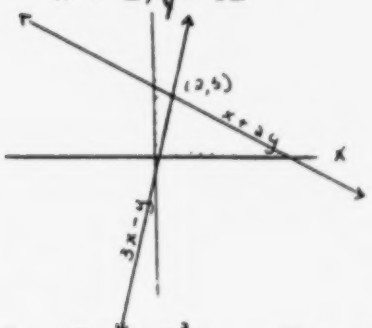
4. $\theta = 20°$



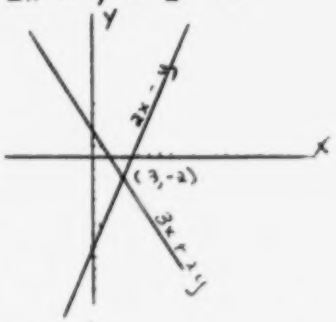
$\theta = 120°$



6. $3x - y = 1$
$x + 2y = 12$



$3x + 2y = 5$
$2x - y = 8$



8. $(5 \times 10^3) + (7 \times 10^3) = 1.2 \times 10^4$
$(9.2 \times 10^3) - (8.7 \times 10^3) = 5 \times 10^2$

11. $(4a^2b^1)^2 = 16a^4b^2$ $\quad (3a^2b^2)^2 = 9a^4b^4$

13. $\sqrt{4a^4b^2} = 2ab$ $\quad \sqrt{25a^4b^2} = 5a^2b$

15. $(a + b)^2 = a^2 + 2ab + b^2$ $\quad (3x + 2)^2 = 9x^2 + 12x + 4$

17. $a^5 \times a^6 = a^{11}$ $\quad b^4/b^3 = b$

18. $(b^3)^4 = b^{12}$ $\quad (c^{-1})^2 = c^{-2}$

19. $(x^a/y^b)^c = x^{ac}/y^{bc}$ $\quad (x^m/y^n)^p = x^{mp}/y^{np}$

20. $a^{-4}b^{-2} = \frac{1}{a^4b^2}$ $\quad x^{-3}y^{-6} = \frac{1}{x^3y^6}$

21. $(25)^{1/2} = 5$ $\quad (8)^{1/3} = 2$

22. $\sqrt{4/9} = 2/3$ $\quad \sqrt{16/25} = 4/5$

25. $8 - (-3x) + 2y = 8 + 3x - 2y$
$4(p - 5) - 3(p - 2) = p - 14$

31. R_1, R_2, R_3, R_4 are in a series.

$R = 10\Omega \quad R = 20\Omega \quad R = 30\Omega$
$R_1 + R_2 + R_3 + R_4 = 100\,\Omega$
$10 + 20 + 30 + R_4 = 100\,\Omega$
$R_4 = 40\,\Omega$
$E_1 = 50v \quad E_2 = 125v \quad E_3 = 75v$
$E_s = E_1 + E_2 + E_3$
$E_s = 250v$

32. Given: $E = 110v \quad I = 5a$
$P = ?$
$R = \frac{E}{I} = \frac{110}{5} = 22\,\Omega$
$P = I^2R = 5^2 \times 22 = 550w$

$I = 10a \quad E = 110v$
$P = ?$
$R = \frac{E}{I} = \frac{110v}{10a} = 11\,\Omega$
$P = I^2R = 10^2 \times 11 = 1100w$

33. $R_1 = 20\Omega \quad R_2 = 50\Omega \quad R_3 = 30\Omega \quad I = 2.5a$
$E_1 = IR_1 = 2.5 \times 20 = 50v$
$E_2 = IR_2 = 2.5 \times 50 = 125v$
$E_3 = IR_3 = 2.5 \times 30 = 75v$
$E_c = E_1 + E_2 + E_3 = 250v$
$R_c = 300\Omega \quad I = 250ma \quad E = 120v$
$E_c = IR_c = 250 \times 300 = 75v$
$E_x = E - E_c = 120 - 75 = 45v$
$R_x = \frac{E_x}{I} = \frac{45}{.250} = 180\,\Omega$

34. $y^2 - 36 = 0$
$y = \pm 6$

$x^2 = 625$
$x = \pm 25$

35. $6a^2 + 3a - 7 = 0$
$a = \frac{-3 \pm \sqrt{9 + 168}}{12}$
$a_1 = \frac{10.304}{12} = .858$
$a_2 = \frac{-16.304}{12} = -1.359$

$8b + 4a - 6 = 0$
$a = \frac{-4 \pm \sqrt{16 + 192}}{16}$
$a_1 = \frac{10.422}{16} = .651$
$a_2 = \frac{-18.422}{16} = -1.151$

37. $3x + 3yx = 1$
$3x(1 + y) = 1$

$27b^2a + 3cba = 0$
$3ba(9b + c) = 0$

38. $3ax^2 + 6ax + 3ay^2 = 0$
$3a(x^2 + x + y^2) = 0$

$5by^2 + 15cby + 25bx = 0$
$5b(y^2 + 3cy + 5x) = 0$

39. $(x + y)(x - y) = x - y$

$(2b + 2a)(2b - 2a) = 4b - 4a$

41. $x + 3 = 13$
$+(x - y = 1)$
$2x = 14$
$x = 7$

$6x + 2y = 12$
$-(4x - 2y = 3)$
$2x = 9$
$x = 9/2$

42. $c + 4b = 8$

$b + a = 6$

$2c - 6b = 7$
$c = 8 - 4b$
$2(8 - 4b) - 6b = 7$
$-14b = -9$
$b = 9/14$
$c = 8 - 4(9/14)$
$c = 38/7$

$a - b = 2$
$a = 2 + b$
$b = 2$
$b + (2 + b) = 6$
$2 + 2b = 6$
$b = 2$
$a = 2 + 2 = 4$

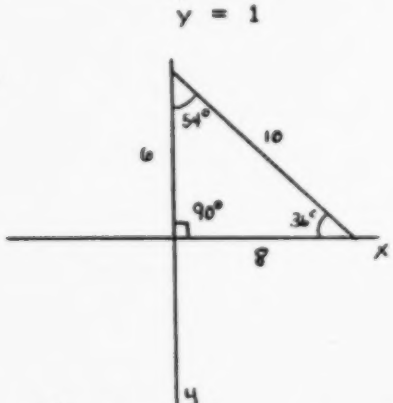
43. (1) $x - 4y = 14$
(2) $4x + y = 5$
(1) $x = 14 + 4y$
(2) $x = \frac{5 - y}{4}$
$14 + 4y = \frac{5 - y}{4}$
$56 + 16y = 5 - y$
$17y = -51$
$y = -3$
(1) $x + 12 = 14$
$x = 2$

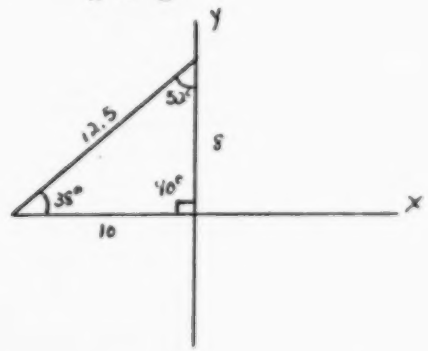
(1) $2x + y = 14$
(2) $4x - 3y = 8$
(1) $2x = 14 - y$
$x = 7 - 1/2y$
(2) $4x = 8 + 3y$
$x = 2 + 3/4y$
$7 - 1/2y = 2 + 3/4y$
$28 - 2y = 8 + 3y$
$-2y = 8 + 3y - 28$
$2y = -8 - 3y + 28$
$5y = 20$
$y = 4$
(1) $x = 7 - 2$
$x = 5$

44. $\frac{x}{4} + \frac{y}{3} = \frac{7}{12}$
$\frac{x}{2} - \frac{y}{4} = \frac{1}{4}$
(1) $3x + 4y = 7$
(2) $2x - y = 1$
$11x = 11$
$x = 1$
(1) $3 + 4y = 7$
$4y = 4$
$y = 1$

$\frac{x}{2} - \frac{y}{10} = 3$
$\frac{x}{4} + \frac{y}{5} = 4$
(1) $5x - y = 30$
(2) $-(5x + 4y = 80)$
$-5y = -50$
$y = 10$
(1) $5x - 10 = 30$
$5x = 40$
$x = 8$

52.





54. $6x^2y$ & $7x^3y^2$ Least common multiple : $42x^3y^2$
$8x^4y^5$ & $9zy^4$ Least common multiple : $72zx^4y^5$

55. $\frac{14x^3y^2z}{7x^2y} = 2xyz$

$\frac{64x^4y^3z^4}{8x^2y\ z^3} = 8x^2y^2z$

56. $-\left(\frac{a}{-c}\right) = \frac{a}{c}$ $\qquad -\left(\frac{d}{e}\right) = \frac{-d}{e}$

57. $\frac{e^3}{4} - 4 = \frac{e^3 - 16}{4}$ $\qquad \frac{\frac{12x^2}{y^3}}{\frac{4x^3}{3y^5}} = \frac{9y^2}{x}$

59. Ohm's Law :
Current is equal to the direct proportion of voltage to resistance.

$$I = \frac{E}{R}$$

Kirchhoff's Law :
The algebraic sum of the currents at any junction of conductors is zero.

$$R_1 I + R_2 I + R_3 I = 0$$

60. $5^2 = 25$ $\qquad 2 = \log_5 25$
$5^4 = 625$ $\qquad 4 = \log_5 625$

61. $\log_{10} (100 \times 10{,}000) = \log_{10} 100 + \log_{10} 10{,}000 = 6$
$\log_4 (64 \times 2) = \log_4 64 + \log_4 2 = 3.5$

62. $\log_{10} \frac{10}{1} = \log_{10} 10 - \log_{10} 1 = 1 - 0 = 1$
$\log_4 \frac{625}{64} = \log_4 625 - \log_4 64 = 5 - 3 = 2$

63. $\log_{10} 100^2 = 2 \log_{10} 100 = 4$
$\log_2 8^2 = 2 \log_2 8 = 6$

64. $\log_{10} \sqrt{10{,}000} = 1/2 \log_{10} 10{,}000 = 4/2 = 2$
$\log_{10} \sqrt[3]{100} = 1/3 \log_{10} 100 = 2/3$

65. $\log_{10} 140 = 2.1461$ $\qquad \log_{10} 63 = 1.7993$

66. $\log_{10} 10{,}000 = 4$ $\qquad 10^4 = 10{,}000$
$\log_2 16 = 4$ $\qquad 2^4 = 16$

67. antilog 2.8401 = 692 $\qquad$ antilog .9101 = 8.13

68. 3.6874 + 2.3265 = 6.0139 $\qquad \bar{4}.3265 = 6.3265 - 10$

$$\begin{array}{r} +6.2843 \\ \hline 12.6108 - 10 \end{array}$$

$2.6108 =$

69. $4.1073 = 14.1073 - 10$ $\qquad 1.6725 = 11.6725 - 10$

$$\begin{array}{r} -6.9860 \\ \hline 7.1213 - 10 \end{array} \qquad \begin{array}{r} -5.7856 - 10 \\ \hline 5.8869 \end{array}$$

70. $p = 2.79 \times 684$

$\log p = \log 2.79 + \log 684 = 0.4456 + 2.8351 = 3.2807$

$p = 1908$

$x = 6.28 \times 10{,}600{,}000 \times .0000251$

$\log x = \log 6.28 + \log 10{,}600{,}000 + \log .0000251 = 3.2230$

$x = 1671$

72. $q = \frac{948}{237}$ $\log q = \log 948 - \log 237 = 2.9768 - 2.3747$

$\log q = .6021$ $q = 4$

$p = \frac{-24.68}{682{,}700}$ $\log p = \log 24.68 - \log 682{,}700$

$\log p = (11.3923 - 10) - 5.8342 = 5.5581 - 10$

$p = -3.615 \times 10^{-5}$

73. $\log \frac{642 \times 8.63}{37.2} = (\log 642 + \log 8.63) - \log 37.2$

$= (2.8075 + .9360) - 1.5705$

$= 2.173$

$\log \frac{3793 \times 70.2}{265} = (\log 3793 + \log 70.2) - \log 265$

$= (3.5790 + 1.8463) - 2.4232$

$= 3.0021$

78. $i = \frac{E}{R}(1 - \varepsilon^{-\frac{Rt}{L}})$ $i = \frac{12}{15}(1 - \varepsilon^{-\frac{15 \times .04}{.75}})$

$i = 0.8(1 - \varepsilon^{-1.2})$ $i = 0.8 - 0.8\varepsilon^{-1.2}$

$i = 0.8 - \frac{.8}{\varepsilon^{1.2}}$ $\log_{10} \varepsilon^{1.2} = 1.2 \log_{10} \varepsilon$

$\log_{10} \varepsilon^{1.2} = 1.2 \log_{10} \varepsilon = 1.2 \times .4343 = .5212$

$\varepsilon^{1.2} = 3.32$ $i = .8 - \frac{.8}{3.32}$

$i = .559a$

$i = \frac{E}{R}\varepsilon^{-\frac{t}{RC}}$ $i = \frac{.3E}{R} = \frac{.3 \times 110}{500} = .066a$

$.066 = \frac{110}{500}(\varepsilon^{-\frac{t}{500 \times 20 \times 10^{-6}}})$

$.066 = .22\varepsilon^{-\frac{t}{10^{-2}}} = .22\varepsilon^{-100t}$

$.3 = \varepsilon^{-100t} = \frac{1}{\varepsilon^{100t}}$ $.3\,\varepsilon^{100t} = 1$

$\varepsilon^{100t} = 3.33$ $\log_{10} \varepsilon^{100t} = \log_{10} 3.33$

$\log_{10} \varepsilon^{100t} = \log_{10} 3.33$ $100t \log \varepsilon = \log 3.33$

$100t \times .4343 = .5224$ $43.43t = .5224$

$t = .012$ sec

79. $db = 10 \log_{10} \frac{P_2}{P_1}$ $\quad P_1 = 10$ milliwatts $\quad P_2 = 120$ milliwatts

$db = 10 \log \frac{120}{10} = 10 \log 12 = 10.8$ db gain

$P_1 = 6 \quad db = -64$

$-64 = 10 \log \frac{P_2}{6} \qquad -6.4 = \log \frac{P_2}{6}$

$3.6 - 10 = \log \frac{P_2}{6} \qquad 3.98 \times 10^{-7} = \frac{P}{6}$

$P_2 = 2.39 \times 10^{-6}$ mw

80. How much power is represented by a gain of 23 db ?

$23 = 10 \log \frac{P_2}{6} \qquad 2.3 = \log \frac{P_2}{6}$

$\text{antilog } 2.3 = \frac{P_2}{6} \qquad 199.5 = \frac{P_2}{6}$

$P_2 = 1197$ mw

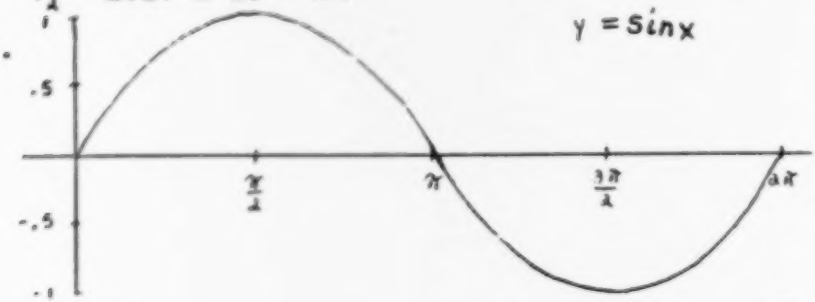
How much power is represented by -64 db ?

$-64 = 10 \log \frac{P_2}{6} \qquad -6.4 = \log \frac{P_2}{6}$

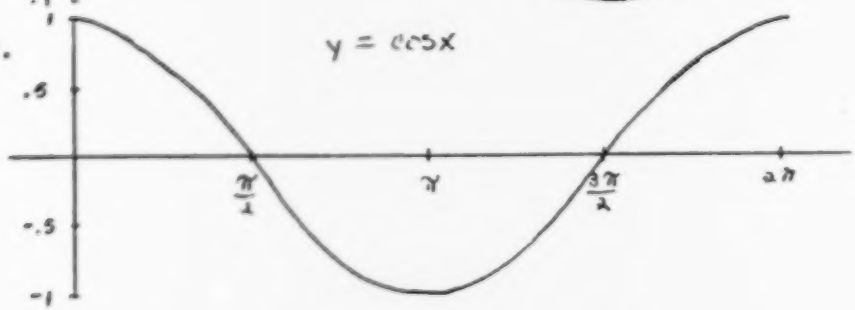
$\text{antilog } -6.4 = \frac{P}{6} \qquad 3.98 \times 10^{-7} = \frac{P_2}{6}$

$P_2 = 2.39 \times 10^{-6}$ mw

84. $y = \sin x$



85. $y = \cos x$



86. $f = \frac{w}{2\pi}$ ~ $\qquad w = 377$

$f = \frac{377}{2\pi} = 60$ ~

$w = 455 \qquad f = \frac{455}{2\pi} = 72.4$~

87. $w = 2\pi f \qquad f = 56$

$f = 30 \qquad w = 2\pi \times 56 = 351.86$ r/s

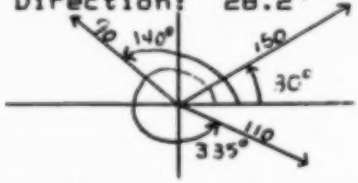
$w = 2\pi \times 30 = 188.4$ rad/sec

88. $y = 25 \sin (2\pi t + 30°)$; $r = 25$
$y = 32 \sin (37.7t - 10°)$; $r = 32$

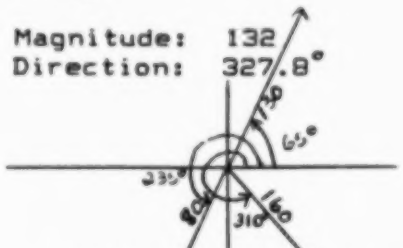
89. $e = 325 \sin (314t - 18°)$; period = .02
$e = E_m \sin (157t + 17°)$; period = .04

90. $i = I_m \sin (6.28 \times 10^3 - 90°)$; 90° lag
$y = 32 \sin (120t - 30°)$; 30° lag

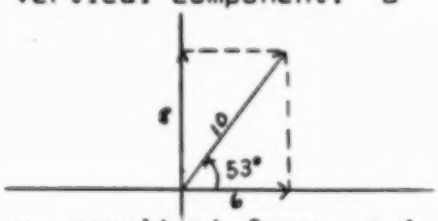
91. Magnitude: 182.5
Direction: 28.2°



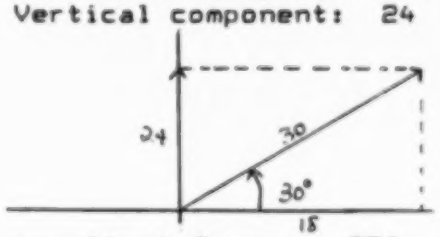
Magnitude: 132
Direction: 327.8°



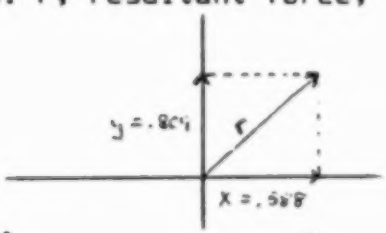
92. Horizontal component: 6
Vertical component: 8



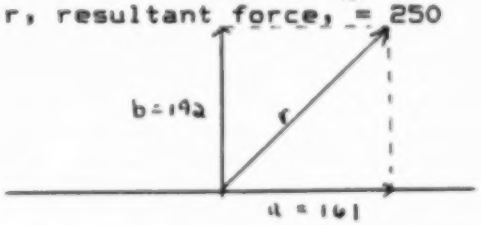
Horizontal component: 18
Vertical component: 24



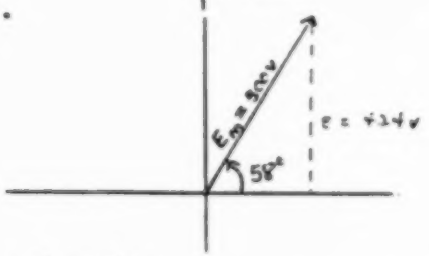
93. r, resultant force, = 1

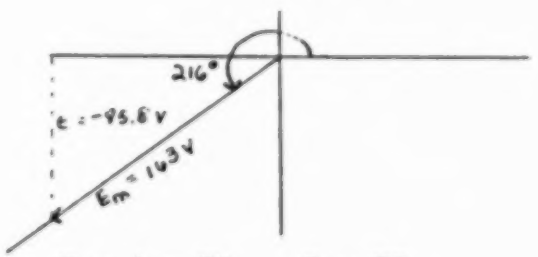


r, resultant force, = 250

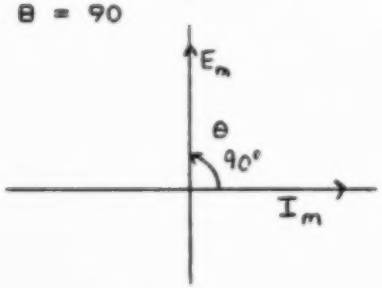


94.

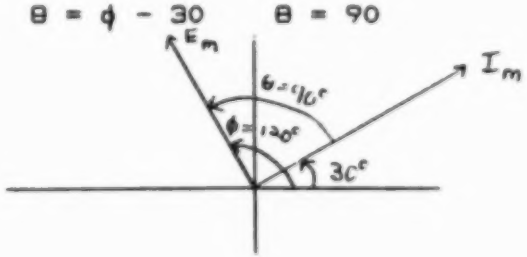




95. $\theta = 90$



$\theta = \phi - 30$ $\theta = 90$



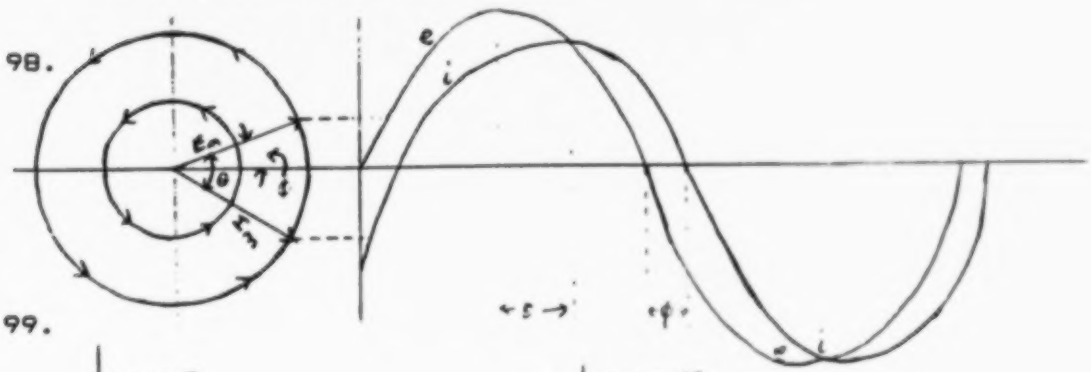
96. $f = 30 \quad w = 2\pi \times 30 = 188.4$ rps

$f = \frac{300 \text{ rpm}}{60} = 5$ rps $\quad w = 2\pi \times 5 = 10\pi$ or 31.4 rps

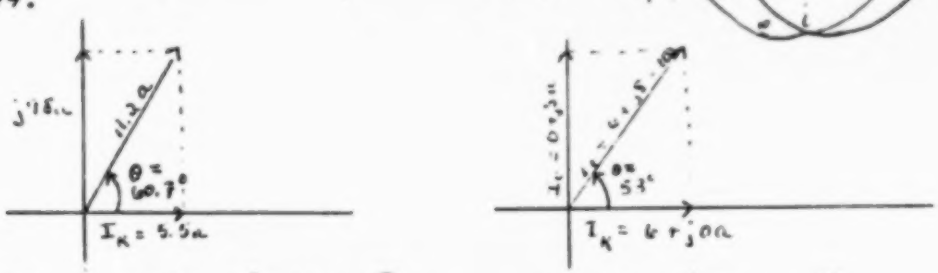
97. Maximum voltage : 170 volts
Maximum current : 14.1a
Frequency : 800
Phase angle : 40° lag
Voltage angle : 10
e = 170 sin 5030t v
i = 14.1 sin (5030t - 40°) a

Maximum voltage : 220 v
Maximum current : 14a
Phase angle : 60° lag
$E = \sqrt{2}\,E = \sqrt{2} \times 220 = 311$v
$\phi = 245° + 60° = 305° = -55°$
e = 311 sin (-55°) = -255 n

98.



99.



100. $Z = 269 \angle -21.8\ \Omega$ $\quad Z = 10 \angle -53.1\ \Omega$

101. $Z = R - jx = 250 - j100$ ohms

$\tan \theta = \frac{x}{R} = \frac{100}{250} = .4 \qquad \theta = -21.8°$

$Z = \frac{x}{\sin \theta} = \frac{100}{\sin 21.8°} = 269\ \Omega$

or $Z = \frac{R}{\cos \theta} = \frac{250}{\cos 21.8°} = 269\ \Omega$

$Z = 269 \angle 21.8\ \Omega$

$\tan \theta = \frac{x}{R} = \frac{141}{75} = 1.88 \qquad \theta = 62°$

$Z = \frac{R}{\cos \theta} = \frac{75}{\cos 62°} = 160\ \Omega \quad Z = 160 \angle 62°\ \Omega$

102. Given : $I_R = \frac{E}{R} = \frac{120}{20} = 6a$ $\quad I_L = \frac{E}{wl} = \frac{120}{15} = 8a$

$I_R = 6.0 + j0a$
$I_L = 0 + j8a$
$I_t = 6 - j8.0a$

Given : $E = 120$ $\quad I_t = 10$ $\quad \theta = 53.1^\circ$

$Z_t = \frac{120}{10} = 12\ \Omega$ $\quad Z = 12(\cos 53.1^\circ + j\sin 53.1^\circ)$
$= 7.2 + j9.6\ \Omega$

103. $I_a = 3.28 \angle -35^\circ a = 2.69 - j1.88a$
$I_b = 5.30 \angle 58^\circ a = 2.81 + j4.50a$
$I_c = 1.71 \angle 20^\circ a = 1.61 + j.585a$
$I_t = 7.11 + j3.205a$

$\theta_{dc} = \frac{3.20}{7.11} = .450 = \angle 24.2^\circ$

$Z_{dc} = \frac{E_{dc}}{I_{dc}} = \frac{100}{7.80} = 12.8 \angle -24.2^\circ\ \Omega$

104.
$4.60 + j2.82$
$+2.11 - j8.10$
$6.71 - j8.10$

$6.4 - j\ 8.5$
$+10.3 + j19.8$
$16.7 + j11.3$

105.
$14.6 + j8.84$
$-\ 3.7 + j4.62$
$10.9 - j13.46$

$25.9 - j46.8$
$-14.7 - j10.4$
$11.2 - j36.4$

106.
$8 + j5$
$10 + j9$
$80 + j50$
$+ j72 + j245$
$80 + j122 - 45$
$= 35 + j122$

$80 + j39$
$35 - j50$
$2800 + j1365$
$- j4000 - j21950$
$2800 - j2635 + 1950$
$= 4750 - j\ 2635$

107. $\frac{50 + j35}{8 + j5} = 6.46 + j.337$ $\qquad \frac{10}{3 + j4} = 1.2 - j1.6$

108. $(8 + j5)(10 + j9) = 127 \angle 74^\circ$
$(80 + j39)(35 - j50) = 5430 \angle -29^\circ$

109. $\frac{50 + j35}{8 + j5} = 6.46 \angle 30^\circ$ $\qquad \frac{10}{3 + j4} = 2.0 \angle -53^\circ$

110.

Decimal	Binary
4	0100
15	1111

111.

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

0 = low voltage

1 = high voltage

A	B	Y
low	low	low
low	high	high
high	low	high
high	high	high

112.

$Y_3 = A + B$
$Y_6 = Y_3 + C = A + B + C$
$Y_8 = Y_6 + D = A + B + C$

113. $Y = \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + A\bar{B}\bar{C} + AB\bar{C}$
$Y = (\bar{A}\bar{B} + \bar{A}B + A\bar{B} + AB)\bar{C}$
$Y = [\bar{A}(\bar{B} + B) + A(\bar{B} + B)]\bar{C}$
$Y = [\bar{A}(1) + A(1)]\bar{C} = (\bar{A} + A)\bar{C}$
$Y = \bar{C}$
$Y = A\bar{B}C + ABC$
$Y = (\bar{B} + B)AC$
$= AC$

114.

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

$Y = \bar{A}BC + A\bar{B}C + AB\bar{C} + ABC$

115. $Y = A\bar{B} + AB$
$Y = A(\bar{B} + B)$
$Y = A(1) = A$

$Y = (\bar{A}+B)(A+B)$
$Y = \bar{A}A + \bar{A}B + BA + BB$
$Y = \bar{A}B + AB + B$
$Y = B$

116.

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

	$\bar{B}$	B
$\bar{A}$	0	0
A	1	1

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

	$\bar{C}$	C
$\bar{A}\bar{B}$	0	0
$\bar{A}B$	1	0
AB	1	1
$A\bar{B}$	0	0

117.

	$\bar{C}$	C
$\bar{A}\bar{B}$	0	0
$\bar{A}B$	1	0
AB	1	1
$A\bar{B}$	0	0

Three variable

	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	1	0	0
$\bar{A}B$	0	0	1	1
AB	0	0	0	1
$A\bar{B}$	0	0	0	0

Four variable

118.

	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	0	0	0
$\bar{A}B$	0	0	0	0
AB	1	1	1	1
$A\bar{B}$	1	1	1	1

Octet

	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	1	1	1
$\bar{A}B$	0	0	0	1
AB	1	1	0	1
$A\bar{B}$	1	1	0	1

Octets, quads, and pairs

119. $Y = (A + B + C)(A + B + \bar{C})(A + \bar{B} + C)$

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

$Y = (A + \bar{B} + \bar{C})(A + \bar{B} + \bar{C})(\bar{A} + \bar{B} + C)$

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

120. $Y = (A + B + C)(A + \bar{B} + \bar{C})(\bar{A} + \bar{B} + C)$

A	B	C	Y	
0	0	0	0	$\longrightarrow A + B + C$
0	0	1	1	
0	1	0	1	
0	1	1	0	$\longrightarrow A + \bar{B} + \bar{C}$
1	0	0	1	
1	0	1	1	
1	1	0	0	$\longrightarrow \bar{A} + \bar{B} + C$
1	1	1	1	

A	B	C	Y	
0	0	0	0	
0	0	1	0	
0	1	0	0	
0	1	1	1	$\longrightarrow \bar{A}BC$
1	0	0	0	
1	0	1	1	$\longrightarrow A\bar{B}C$
1	1	0	1	$\longrightarrow AB\bar{C}$
1	1	1	1	$\longrightarrow ABC$

121. $Y = (\bar{A} + B)(A + B)$
$Y = \bar{A}A + \bar{A}B + BA + BB$
$Y = \bar{A}B + AB + B$
$Y = (\bar{A} + A)B + B = B + B = B$

$Y = (A + B)(\bar{A} + \bar{B})$
$Y = A\bar{A} + AB + B\bar{A} + BB$
$Y = AB + B\bar{A} + B$
$Y = (A + \bar{A})B + B = B + B = B$

122.

A	B	C	D	Y
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

123. 429

4 ↓ 0100 2 ↓ 0010 9 ↓ 1001

8963

8 ↓ 1000 9 ↓ 1001 6 ↓ 0110 3 ↓ 0011

124. 1 0 1 → 4 ∄ 1 → 4 + 1 = 5

1 0 1 0 1 → 16 ∄ 4 ∄ 1 → 16 + 4 + 1 = 21

125. Octal 23

$2(8^1) + 3(8^0) = 16 + 3 = 19$

Octal 257

$2(8^2) + 5(8^1) + 7(8^0) = 128 + 40 + 7 = 175$

126. decimal 23

0.23 x 8 = 1.84 = .84 with carry of 1

0.84 x 8 = 6.72 = 0.72 with carry of 6

0.72 x 8 = 5.76 = 0.76 with carry of 5

octal fraction 0.165

decimal 175

$8\overline{)2}$ 0

$8\overline{)21}$ 2

$8\overline{)175}$ 5 7

257

127. 9 ↓ 1001 A ↓ 1010 F ↓ 1111

C ↓ 1100 5 ↓ 0101 E ↓ 1110 2 ↓ 0010

128. 12

1	2	4	5
+3	+3	↓	↓
4	5	0100	0101

29

2	9	5	12
+3	+3	↓	↓
5	12	0101	1100

129. 0011 0110

3	6	
-3	-3	
0	3	3 decimal

1001	01111	
↓	↓	
9	7	
-3	-3	
6	4	64 decimal

130.

Gray number	Decimal
1110	11
1000	15

131.

0101	0111		O F A C H
+0011	0101		+3 8 7 F H
1000	1100		4 8 2 B H

132.

11100		0000	1111	1010	1100
+11010		+0011	1000	0111	1111
110110		0100	1000	0010	1011

133. Whole numbers, base 10

4,012
+14,463
18,475

16 bit numbers

0000	1111	1010	1100
+0011	1000	0111	1111
0100	1000	0010	1011

134.

1100	1000		1001	0110
-0111	1101		-0101	0101
0100	1011		0100	0001

135. $9_{10} - 1_{10} = 8_{10}$ $175_{10} - 50_{10} = 125_{10}$

136. $175_{10} + 118_{10} = 293_{10}$

	1010	1111		0111	1101
overflow	+0111	0110	overflow	+1011	1100
↳1	0010	0101	↳1	0011	1001

137. -127 = 1111 1111 32,767 = 0111 1111 1111 1111

138. 1001 = -001 = -1

1010 = -010 = -2

139. 23H
1's complement :
DCH

FDH
1's complement :
02H

140. 0000 1111
2's complement :
0001 0100

1000 0001
2's complement :
0111 111

141. +78
2's complement :
0100 1110

-90
2's complement :
1010 0110

142.
```
 45          0010   1101
+56         +0011   1000
---         -----   ----
101          0110   0101

 89          0101   1001
+-34        +1101   1110
---         -----   ----
 55          0011   0111
```

Table 10

EXAMPLES FOR MACHINE SHOP MATH COMPETENCIES

78. 20.48 miles = (20.48 x 1.069 km) = 21.893 km

79. Hole size : 1.498 to 1.502 inches
Tolerance : .004 inch

Open-end wrench (opening size) : .562 - .567 inches
Tolerance : .005 inch

80. Circumference = π x D
Radius = 2.1 ft.
Circumference = 13.19 ft.
Diameter = 1/2 inch
Circumference = 1.5708 inches

81. Perimeter of any Polygon = Sum of its Sides
S = 4 inches; Perimeter of a square = 4 + 4 + 4 + 4
= 16 inches

S = 2.378 mm
Perimeter of a hexagon = 2.378 + 2.378 + 2.378 + 2.378
+ 2.378 + 2.378 = 14.268 mm

82. Area of a circle = πr^2
r = 3 inches Area = π x 9 in. = 28.274 in
r = 15.4715 feet Area = π x 239.36731 ft. = 752 ft.

83. Pitch of a thread = $\frac{1}{\text{number of threads per inch}}$
N = 8.5 P = $\frac{1}{8.5}$ = .1176
N = 14 P = $\frac{1}{14}$ = .07142

84. Cutting speed = π x D x rpm
Rpm = 400
Diameter = 2"
CS = π x 2 x 400 = 2513.274 in/min = 209.44 ft/min
Rpm = 170
Diameter = 1 1/8"
Cs = π x 9/8 x 170 = 600.83 in/min = 50.069 ft/min

85. In a working year of 2400 hrs Maddie was absent from work for 72 hours. What percent of time was she absent?

$$\frac{72}{2400} \times 100\% = 3\%$$

946 pounds of brass has 138 pounds of zinc. What percentage of the brass is zinc ?

$$\frac{138}{946} \times 100\% = 14.59\%$$

86. 7 graduations exposed thimble reading is 8

Reading : .183 in.
Six full turns starting from zero; reading .150 in

87. Zero is at 2" and 6 graduations and the vernier coincides with the tenth line.
Reading : 2.160 in
Zero is at 1" and 3 graduations and the vernier coincides with the eigth line.
Reading : 1.083 in

88. 30 spaces on the vernier
The vernier zero is between 35° 30' and 36°
The coinciding line is at 14
Total reading : 35° 44'

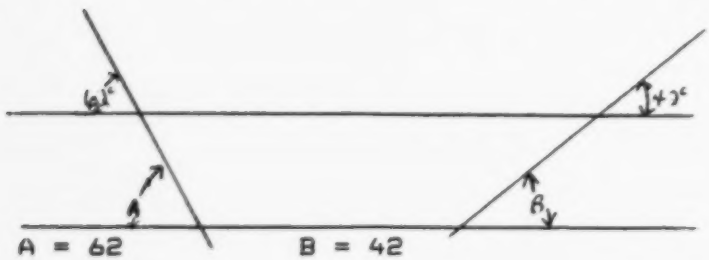
Vernier zero between 15° and 15° 30'
Coinciding vernier line at 12
Total reading : 15° 12'

89. $90^\circ - 21\ 53' = 68^\circ 07'$
$69^\circ 18' - 68^\circ 19'31" = 58'29"$

90. $\frac{30'}{60} = .5^\circ$ $\qquad\qquad$ $\frac{19'}{60} = .317^\circ$

91. $6.53^\circ = 6^\circ + (.53 \times 60) = 6^\circ + 31.8' = 6\ 32'$
$11.7251^\circ = 11^\circ + (.7251 \times 60) = 11^\circ + 43.506'$
$= 11^\circ + 43' + (.506 \times 60) = 11^\circ 43'30"$

92.



A = 62 B = 42

A = 110

93. Area of a triangle
Sides are : 5 cm, 8cm, and 11cm
Area = 18.33 sq. in.
Area of a parallelogram
Base : 2'9"
Altitude : 5'4"
Area = 14.67 sq. ft.
Area of a rectangle

Diagonal : 125'
Altitude : 75'
Area = 7500 sq. ft.
Area of a square
Diagonal : 12"
Area = 72 sq. in.

94. Distance across the flats of a square nut : 2 7/8
Diagonal = 4 1/16 in
Side of a square = 8.485 in
Diagonal = 12 inches

95. F = Distance Across Flats = $\frac{c}{1.155}$ c = Distance Across Corners

96. tan 36° 50' = .74900 cos 77° 20' = .21928

97. sin 15° 23' = ?

$$10\begin{cases}3\begin{cases}\sin 15^\circ 20' = .26443\\ \sin 15^\circ 23' = ?\end{cases}\\ \sin 15^\circ 30' = .26724\end{cases}$$
$$.00281$$
$$\frac{3}{10} \times .00281 = .00084$$
$$.26443$$
$$-.00084$$
$$\sin 15^\circ 23' = .26527$$

cos 82° 51' = ?

$$10\begin{cases}1\begin{cases}\cos 82^\circ 50' = .12476\\ \cos 82^\circ 51' = ?\end{cases}\\ \cos 83^\circ = .12187\end{cases}$$
$$.00289$$
$$\frac{1}{10} \times .00289 = .0029$$
$$.12476$$
$$-.00029$$
$$\cos 82^\circ 51' = .12447$$

98. $\frac{c}{\sin C} = \frac{d}{\sin D}$ $\frac{b}{\sin B} = \frac{C}{\sin C}$ $\frac{b}{\sin B} = \frac{d}{\sin D}$
B = 25° D = 80° b = 15 inches
Find C, c and d
$\frac{15}{\sin 25^\circ} = \frac{d}{\sin 80^\circ}$ d = 34.954 inches
C = 75°
$c = \frac{b \sin C}{\sin B}$ C = 34.284 inches

99. b = 10 ft d = 12 ft C = 36°
Find c

Find c

$c^2 = b^2 + d^2 - 2bd \cos C = 100 + 144 - 194.165 = 49.835$

$c = \sqrt{49.835} = 7.059$ ft

Find B

$\sin B = \frac{10\ (.58779)}{7.059} = .83268$ $\quad B = 56^\circ 23'$

100. Find the taper per inch

D = 4.576 d = 4.013 L = 10 inches

TPI = (D - d)/L

= (4.576 - 4.013)/10 = .0563 in per in

D = .200 inch d = .162 inch L = $1\frac{13}{16}$

$TPI = \frac{(.200 - .162)}{1.8125} = .02096$ in per in

101. $\text{Offset} = \frac{\text{TPI} \times \text{Total Work Length Between Centers}}{2}$

TPI = .0357 in

Length between centers = 14

$\text{Offset} = \frac{.0357 \times 14}{2} = .250$ in

TPI = .0778

Length between centers = 15

$\text{Offset} = \frac{.0778 \times 15}{2} = .5835$ in

102. Length = 6 inches D = 4.665 inches d = 3.105 inches

$\frac{2 \times \tan \text{taper}}{24}$ = corresponding angle

$\frac{2 \times \tan .26}{24} = 14^\circ 48'$

Length = 12 in D = 2.005 in d = 1.03 in

$\text{Taper} = \frac{2.005 - 1.03}{12} = .08125$

Corresponding angle = $4^\circ 40'$

103. TPI = .026 in; in 3 inches, TPI should be .078 in

D = 1.562 d = 1.500 D - d = .062 in

$\text{Error per inch} = \frac{.078 - .062}{3} = .0053$ in

TPI = .0208 in; in 4 inches, TPI should be .0804 in

D = 1.251 in d = 1.232 in D - d = .019 in

$\text{Error per inch} = \frac{.0804 - .019}{4} = .01535$ in

104. T = Number of Teeth on Driver S = Speed of the Driver

t = Number of Teeth on the Driven Gear

s = Speed of Driven Gear

T x S = t x s

t = 20 s = 150 rpm T = 30

$S = \frac{t \times s}{T} = \frac{(20)150}{30} = 100$ rpm

$T = 20 \quad s = 200$ rpm $\quad t = 40$

$s = \frac{T \times S}{t} = \frac{20 \times 200}{40} = 100$ rpm

105. $T = 64 \quad S = 700$ rpm $\quad s = 400$ rpm

$t = \frac{T \times S}{s} = \frac{64 \times 700}{400} = 112$

Rpm of Final Driven Gear =
Product of all Driving Teeth x Rpm of First Driving Gear
Product of all Driven Teeth

Rpm of A = 300 $\quad$ A = 24 T $\quad$ B = 64 T $\quad$ C = 36 T

D = 20 T

$Rpm = \frac{300 \times 24 \times 64}{20 \times 36} = 640$

106. Rpm of Gear x Thread Number = Speed of Worm x Number of Teeth on Worm Gear

Rpm of gear = 120 rpm
Thread number = 1
Number of teeth on worm gear = 60

$Speed\ of\ worm\ gear = \frac{120\ rpm \times 1}{60} = 2$ rpm

Number of teeth = 40
Speed of gear = 80 rpm
Thread number = 1

$Rpm\ of\ gear = \frac{80 \times 1}{40} = 2$

107. $Rpm = \frac{4CS}{D} \quad D = 3 \quad CS = 300$

$Rpm = \frac{4(300)}{3} = 400$

$D = 5 \quad CS = 375$

$Rpm = \frac{4(375)}{5} = 300$

108. $Rpm = 4CS = \frac{4(125)}{2} = 250$

$250 \times .75 = 188$ rpm

$Rpm = \frac{4(125)}{.5} = 1000$rpm

$1000 \times .75 = 750$ rpm

109. Rate of Feed = Chip Load per Tooth x Number of Teeth x rpm

Chip load = .007
Number of teeth = 30
Rpm = 83
Rate = .007 x 30 x 83 = 17.43 per minute

Chip load = .002
Number of teeth = 12
Rpm = 86
Rate = .002 x 12 x 86 = 2.064

110. Cutting Time = $\frac{\text{Length of Cut}}{\text{Feed Rate per Minute}}$
Length of cut = 5.5
Feed rate = 2.2/min
Cutting time = $\frac{5.5}{2.2}$ = 2.5 minutes
Length of cut = 2
Feed rate = .75/min
Cutting time = $\frac{2}{.75}$ = 2.67 minutes

111. Pitch = $\frac{1}{N}$. N = 32 P = $\frac{1}{32}$ = .0312
N = 13 P = $\frac{1}{13}$ = .0769

112. M = D - 1.515 P + 3G
G = .57735 P P = .0556 D = .3125
M = .3125 - 1.515(.0556) + 3(.03208) = .3244 inch
h = single depth of a thread = .6495P
P = .0312
h = .6495(.0312) = .0203

113. N x .013 + .060 = Outside Diameter of Machine Screws
N = 10
10 x .013 + .060 = .130 + .06 = .19 inch
Tap Drill Size = TDS = OD - P
OD = 3/8 P = .0625
TDS = .375 - .0625 = .3125

114. Outside Diameter = OD = $\frac{N + 2}{DP}$
DP = 18 N = 44
OD = $\frac{44 + 2}{18} = \frac{46}{18}$ = 2.55
DP = 24 N = 36
OD = $\frac{36 + 2}{24} = \frac{38}{24}$ = 1.58

115. C = $\frac{N + N}{2DP}$
DP = 6 N = 18 N = 48
C = $\frac{18 + 48}{2 \times 6} = \frac{66}{12}$ = 5.5
DP = 16 N = 36 N = 54
C = $\frac{36 + 54}{2 \times 16} = \frac{90}{32}$ = 2.813

116. See Text book of your choice.

117. N = 50 & 127

(1) $\frac{50}{127} = .3937$

(2) $\frac{3937}{1000}$

N = 45 & 130

(1) $\frac{45}{130} = .3461$

(2) $\frac{3461}{1000} = .3461$

118. Diametral pitch = $\frac{25.4}{\text{Module}}$

Module = 10

Diametral pitch = $\frac{25.4}{10} = 2.54$

Module = 7

Diametral pitch = $\frac{25.4}{7} = 3.63$

119. T = number of complete turns = $\frac{40}{D}$

D = number of divisions desired

D = 8

T = $\frac{40}{8} = 5$

D = 20

T = $\frac{40}{20} = 2$

120. 7° 31'49" 41 spaces on the 49-hole circle

5° 1'45" 19 spaces on the 34-hole circle

Section 4

Resources for Teaching Exit Math Competenices

An information sheet was distributed with the math competency survey for each of the four selected areas (see Appendix 3). The purpose of the information sheet was to identify the textbooks, curriculum materials, audio-visuals materials, and computer software packages that were currently being used to teach math in each of the four training programs.

The advisory committee suggested that the handbook should include information related to the use of computers to assist in technical math instruction. The information sheet asked each instructor to identify if they used a computer and if they did, what type(s) of computers were being used. As shown in Table 11, 13 of the 50 instructors contacted or 26% used computers to assist them in the instruction of math. The TRS 80 was the most predominant computer used. Five of 13 instructors or 69% used the TRS 80.

A number of instructors said the related teacher used computers so they did not respond to the questions about computer use. This may have been a factor in responses from instructors. It may be that students are using computers for math instruction, but they are doing it in a seperate area under the supervision of a related teacher.

Table 11

Numbers of Instructors Using various types of Computers

(N = 13)

Computer Type	Number of Instructors
TRS 80	9
Apple	1
IBM-PC	2
Hand Held TI	1

The information sheet asked instructors to name all commercial software used to teach math. Table 12 listed the software that 5 instructors identifyed. Again, as implied by the instructors, there was the possibility that the related instructors were the ones using the software so the instructors did not respond.

Table 12

Commercial Software Used to Teach Math (N = 5)

Drafting (N = 1)

Adventures in Math - IBM

Algebraic Expressions -Educational Activities

Basic Algebra Series (8 Programs) - Radio Shack

Math Around the House - Radio Shack

On the Road with Basic Math Skills - Radio Shack

Problem Solving in Algebra - Radio Shack

Electricity (N = 2)

Fundamental Math 1-3, Drill & Practice - Random House

Electronics (N = 2)

Calculus, vector Addition - Tandy (N = 1)

Utilizing Computers in Teaching Secondary Math -

National Diffusion Network (N = 1)

Machine Shop

None

Instructors were also asked to provide information about math related software they had developed. Four instructors indicated they had developed software and three of them said they would be willing to share the information. The names of the software and instructors were listed in Table 13.

Table 13

Software Developed by Instructors to Teach Math (N = 3)

Drafting

Problem Solving in Basic and Releted Math - Ralph Brown, Mayo State VTS

Electronics

Ohms Law, (TRS 80, Model 4), Ron Diemer, Jefferson State VTS

Solving Equations for P.E.I.R. & Variations, LW Ritchie, Hazard State VTS

Nine publishing companies were contacted to supply catalogs of math materials (see Appendix B). These catalogs were analyzed to determine which texts and resource materials would be appropriate to assist with math instruction. Tables 14 -21 were compiled from the information supplied by the vocational instructors and by analyzing publishers' catalogs.

Table 14

MATH RESOURCES FOR DRAFTING

Practical Problems in Math for Mechanical Drawing, Larkin, Delmar Publishers

Technical Drawing, 7th and 8th Edition, Giesecke, Spenncer and Mitchell, Macmillan Publishers

Architecture Design and Engineering Drawing, McKnight Publishers

Basic Mathematics Simplified, Olivio and Olivio, Delmar Publishers

Engineering Drawing and Design, 2nd and 3rd Edition. Jensen, and Helsel, McGraw Hill Publishers

Vocational and Technical Math, R.D. Smith, Delmar Publishers

Plane and Spherical Trigonometry, F.A. Ayers Jr., McGraw Hill

Architecture and Residential Drawing and Design, C. E. Kicklighter, Goodheart-Wilcox Publishers

Technical Shop Mathematics, J. Anderson, Industrial Press

Technical Mathematics, Calter, Prentice Hall Publishers

Basic Mathematics for the Trades, Benjamin Cummins, Mowbray Publishers

Mathematics for Trade and Industrial Occupations, Wm. Rogers, Silver Burdett Publishers

Practical Shop Math, T.C. Power, McGraw Hill Publishers

Introduction to Technical Drawing, (Metric), Delmar Pub.

Principles of Mechanical Drawing, Parr, McGraw Hill Publishers

Technical Drawing and Design, Goetsch, Delmar Publishers

Applied Descriptive Geometry, Susan Stewart, Delmar Publishers Inc.

Archetectural Drafting and Design, A. Jefferis & D. Masden, Delmar Publishers Inc.

Computer Aided Design and Drafting, M. Zandi, Delmar Pub.

Table 15

MATH CURRICULUM FOR DRAFTING

Mathematics for Science and Technology, Heath Company

Intermediate Algebra, Heath Company

Trigonometry, Heath Company

Descriptive Statistics, Heath Company

Measuring Tools Explained, Bergwall, (Audio Visual)

Fundamentals of Geometry I and II, Creative Visuals

Algebra and Trigonometry Series, Creative Visuals

Machinery's Handbook and Use of Handouts by Jones
Industrial Press Publications

Table 16

MATH RESOURCES FOR ELECTRICITY

Electrical Principles and Practices, J. Adams, McGraw Hill

Shop Mathematics at Work, Wwlton and Rogers, 3rd Edition

Basic Electronics, Grob, McGraw Hill, 5th Edition

Practical Problems in Mathematics for Electricians, C. Garrard, F.Boyd, & S. Herman, Delmar Publishers Inc.

Electro Mechanisms and Devices, P. Robertson, R. Hunter, R. Allan, Delmar Publishers

Electricity III, Motors, Generators, and Controls, N. Alerich

Direct Current Fundamentals, O.E. Loper, Delmar Publishers

Alternating Current Fundamentals, J.R. Duff & S. Hernan Delmar Publishers Inc.

Basic Mathematics for Electronics, N.M. Cook, McGraw Hill

Industrial Electricity, John Nadon, Bert Gelmine, Edward McLaughlin, Delmar Publishers

Electrical Control for Machines, Kenneth Rexford, Delamr Publishers, 3rd Edition (New for 1987)

Electricity I:Devices Circuits and Materials, T.S. Kubula, Delmar Publishers Inc.,4th Edition

Electricity II: Devices, Circuits, and Materials T.S. Kubula, Delmar Publishers Inc., 4th Edition

Electricity IIII: Motors, Controls, Alternators, Elmar Publishing INc., 4th Edition

Electronics for Industrial Electricians, S.L. Herman, Delmar Publishers Inc.

Basic Mathematics for Electricity and Electronics, Singer & Forester, McGraw Hill, 5th Edition

Mathematics for Electricity and Electronics, Gene Waring, Delmar Publishers Inc.

Table 17

MATH CURRICULUM FOR ELECTRICITY

Basic Electricity and Electronics Explained, DC-AC, Bergwall (Audio Visual)

Understanding Electricity and Electronics, Buban, and Schmitt, McGraw Hill Publishers

Electrical Wiring Residential Mullin and Smith, Delmar Publishers

Electrical Wiring Commercial, Mullin and Smith, Delmar Publishers

Electrical Wiring Industrial, Smith, Delmar Publishers

Electronic Circuits, Heathkit, Zenith

Electro Mechanisms and Devices, L.P. Robertson, B.R. Hunter, R.C. Allan, Delmar Publishers

Bergwall Pridyctions Audio Visual on Rotating Machinery

Audio Active Inc. Basic Electricity Program

Success in Mathematics-Diagnostic Test, Motivational Developmetn Co.

Contemporary Number Power, J.Howett, Contemporary Books Inc.

Bergwall ProductionS Inc., 801, 802, 803, 804, 806, 812, & 813

Basic Electricity and Electronics:Reactive Circuits, National Innovative Media Co. (Video)

Basic Electricity and Direct Current, National Innovative Media Co. (Video)

D.C. Motors, and Single Phase AC Motors. National Innovative Media Co. (Video)
(Note: Electricity and Electronics Video, Slides, Filmstrips, Cassettes, Tramsparencies, and Micro-Computer Software Available from National Innovative Media Co. - Call 800- 962-6662 got free Catalog. All Programs Qualify for VEA Funds and JPTA Grants.

Table 18

MATH RESOURCES FOR ELECTRONICS

Basic Mathematics for Electronics, Cooke,Adams,Dell, McGraw Hill, 5th Edition

Introduction to Applied Physics, Harris, Hemmelburg, McGraw Hill, 4th Edition

Mathematics for Basic Electronics, Grob, McGraw Hill

Basic Mathematics for Electricity and Electronics, McGraw Hill

Mathematics Outline and Review Problems for Basic Electronics Grob, McGraw Hill, 4th Edition

Fundamentals of Electronic Math, Carl Rader, Delmar Publishing Co.

Background Math for a Computer World, Wiley and Ashley

Math for Electricity and Electronics, Gene Waring, Delmar Publishing Inc.

Electronic Mathematics, Thomas Power, Delmar Publishers Inc.

Technical Math and Calculus, Rice and Strange, Prindle Weber, and Schmidt

Basic Math for Trades and Technology, Cleaves and Hobbs, Prentice Hall

Practical Problems in Math for Electronic Technology, Sullivan, Delmar Publishers Inc.

Fundamentals of Technical Math With Calculus, Arthur Kramer, McGraw Hill

Introduction to Electronics: A Practical Approach, Earl Gates, Delmar Publishers, (New for 1987)

Technicians"s Guide to Fiber Optics, Donald Sterling, Delmar Publishing, (New for 1987)

Modern Electronic Mathematics, Richard Sullivan, Delmar Publishers Inc.

Basic Programming for Engineers and Technicians, Frances Guldner, Delmar Publishers

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Table 19

MATH CURRICULUM FOR ELECTRONICS

Laser Technology - Heath

Solid State Electronics - Bobbs Merrill

Electronics Communications - McGraw Hill

Electronics Circuits - Heath

Fiber Optics - Heath

Digital Electronics - Heath

Microprocessors - Heath

Digital Principles and Applications - McGraw Hill

Microcomputers - Heath Kit

D.C. Circuits, A.C. Circuits - Bergwall

850 Digital Electronics - Bergwall (Aidio Visual)

851 Digital Electronics - Bergwall (Audio Visual)

870 Digital Codes - Bergwall (Audio Visual)

880 Robotics Explained - Heath - (Aidio Visual)

870 Digital Codes - Heath - (Audio Visual)

805 Reactive Circuits - Heath - (Audio Visual)

807 Transistors - Heath - (Audio Visual)

802 Basic Electricity-AC- Bergwall - (Audio Visual)

801 Basic Electricity-DC- Bergwall - (Audio Visual)

Vectors and Vector Analysis, and Rotating Vectors, Bergwall (Audio Visual)

Table 20

MATH RESOURCES FOR MACHINE SHOP

Practical Problems in Mathematics for Machinist's, Edward Hoffman, Delmar Publishing Inc.

Math for Machine Technology, Robert Smith, Delmar Publishers Inc.

Modules Covering Machine Shop Practices, Office of Vocational Education, Frankfort, Kentucky

Technical Shop Mathematics, Anderson, Industrial Press

Basic Mathematics Simplified, Olivo & Olivo, Delmar Publishers Inc.

Practical Shop Mathematics, Thomas Power, Delmar Publishers Inc.

Machine Tool Technology and Manufacturing Processes, C.T. Olivio, Delmar Publishing Inc.

Technical Mathematics, Harry Lewis, Delmar Publishers Inc.

Applied General Mathematics, Robert Smith, Delmar Publishers Inc.

Advanced Machine Technology, C.T. Olivo, Delmar Publishers Inc.

Mathematics of the Shop, F.J. McMackin, J.H. Shaver, R.E. Weber, & R.D. Smith, Delmar Publishers Inc.

Practical Problems in Mathematics - Metric System, F. R. Schell, Delmar Publishers Inc.

Table 21

MATH CURRICULUM FOR MACHINE SHOP

Use and Care of Micrometer, (video), Teaching Aids Inc.

How to Read a Metric Micrometer, (video), Teaching Aids Inc.

How to Read a Vernier Caliper, (video), Teaching Aids Inc.

Geometric Form and Positional Tolerancing (video) Teaching Aids Inc.

Appendix 1

Advisory Committee Materials

ADVISORY COMMITTEE

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MINUTES FROM ADVISORY COMMITTEE MEETING ON SEPTEMBER 23

10:00 Greetings and Introductions of the twelve committee members. Each member was formally introduced and gave a brief description of his or her job responsiblities.

10:15 Dr. Crosby discussed the project and project activities that are planned for the project. The project objectives were discussed and Gary Hess gave some background information on how the project was initiated.

10:30 Dr. Crosby discussed the eleven programs and the ways in which he plans to research the exit math criteria needed for each program. He presented an example of the lists supplied from Frankfort, and discussed the ERIC Research in Frankfort. He plans an independent search in other libraries. He then asked the committee for suggestions. A summary of these follows:
Identify what type of computers are in each school.
Identify the types of software used in each school.
Determine if there are copyright problems in duplicating programs.
Review the software currently used.
Survey should include the basic math skills needed at tenth grade level and ask open ended questions about the technical math needed for each vocation.
Survey should be sent to the technical or academic related teacher of each vocation. Bruce Schaeffer said he could supply the names to us.
Gary Hess will send us the master list of math competencies from Frankfort.

11:30 Discussion of math support materials. Jane Hearn discussed Enright. Marlin Duncan discussed the problem of locating appropriate software which introduced skills instead of just drill and practice. The survey should ask instructors what resources they are currently using and what resources work best for them.

1:00 Discussion of math tests. The group discussed the T.A.B.E. test and the merits of the exam. Some members did not concur that it tests at the tenth grade level.

1:15 Handbook discussion. The Handbook should be distributed to all technical instructors. Final competencies should be examined by Business and

Industry representatives.

1:30 Meeting Adjourned.

Appendix 2

Selected Participants - Vocational Instructors

Instructors for Drafting

1. Bill Nash	West Ky. SVTS
2. Chester Cummins	West Ky. SVTS
3. Paul Hammack	Madisonville SVTS
4. Dale McGuire	Daviess
5. Bill Dawkins	Bowling Green SVTS
6. Robert Young	Bowling Green SVTS
7. Terry Wise	Elizabethtown SVTS
8. Robert Hicks	Elizabethtown SVTS
9. John Spoo	Jefferson SVTS
10. Don Mills	Northern Ky. SVTS
11. Don Reynolds	Northern Ky. SVTS
12. Charles Moore	Rowan SVTS
13. Nick Reeves	Ashland SVTS
14. Ralph Brown	Mayo SVTS
15. Neil Brashear	Hazard SVTS
16. Don Carter	Somerset SVTS
17. Jim Fortenberg	Central Ky. SVTS

Instructors for Electricity

1.	Kenneth Dobson	West Ky. SVTS
2.	James Curtis	West Ky. SVTS
3.	Dwight Borum	Madisonville SVTS
4.	Carson Morehead	Bowling Green, SVTS
5.	Glenn Mattingly	Elizabethtown SVTS
6.	Larry Jaggers	Elizabethtown SVTS
7.	Mr. Rosenbaum	Jefferson SVTS
8.	John BARNES	Rowan SVTS
9.	Lowell Ferguson	Ashland SVTS
10.	Virgil Adkins	Ashland SVTS
11.	Dwight Crider	Mayo SVTS
12.	Rudell Stamper	Hazard SVTS
13.	James Webb	Harlan SVTS
14.	Zac Carter	Central Ky. SVTS

Electronics Teachers Who Were Mailed a Survey

Mailed on January 5, 1987

1. Jim Rudd West Ky.

2. John Paris Madisonville SVTS

3. Mike Finn Bowling Green SVTS

4. Frank Fraze Elizabethtown SVTS

5. Ed Demonbrun Elizabethtwon SVTS

6. Richard Brauner Elizabethtown SVTS

7. Forest Sparrow and Robert Rufner Jefferson State SVTS

8. Rob Diemer Jefferson State SVTS

9. Tom Devine Northern Kentucky SVTS

10. Harry Miller Ashland SVTS

11. Jim Porter Mayo SVTS

12. Lamaar Ritchie Hazard SVTS

13. Rob Goodwin Harlan SVTS

14. Michael Dixon Somerset SVTS

15. Louis Owens Central State SVTS

Mailed on January 21, 1987

Instructors for Machine Shop

1.	Marvin Grabowski	West Ky. SVTS
2.	Chuck Mayo	West Ky. SVTS
3.	J. Richard Hinton	Madisonville
4.	Don Gibson	Bowling Green SVTS
5.	Elbert Cook	Bowling Green SVTS
6.	Frank Buckler	Jefferson SVTS
7.	Bill Lewis	Northern Ky. SVTS
8.	Michael Davis	Rowan SVTS
9.	Wendell Jackson	Ashland SVTS
10.	Norman Miller	Mayo SVTS
11.	J.D. Mullins	Hazard SVTS
12.	Harold Hensley	Harlan SVTS
13.	Walter TAylor	Somerset SVTS
14.	Curtis Carter	Somerset SVTS
15.	Robert Kraft	Central Ky. SVTS

Appendix 3

Information Sheet
Drafting Survey
Electricity and Electronics Survey
Machine Shop Survey

INFORMATION SHEET

NAME _____

SCHOOL _____

PHONE NUMBER _____

1. LIST THE MAJOR UNITS IN YOUR COURSE.
   NOTE - YOU MAY WANT TO INCLUDE YOUR COURSE OUTLINE TO ADD EXPLAINATION.

   _____

   _____

   _____

2. ARE YOU A DAY OR EVENING INSTRUCTOR _____ ?

3. DO YOU USE A COMPUTER TO ASSIST IN TECHNICAL MATH INSTRUCTION _____ (YES OR NO)?

4. IF YOU ANSWERED YES TO #3, WHAT TYPE OF COMPUTER(S) DO YOU USE IN YOUR PROGRAM TO TEACH MATH?

   _____

   _____

   _____

5. HAVE YOU DEVELOPED SOFTWARE TO ASSIST WITH TECHNICAL MATH INSTRUCTION _____ (YES OR NO)?

6. IF YOU ANSWERED YES TO #5, WOULD YOU BE WILLING TO SHARE THE SOFTWARE YOU HAVE DEVELOPED _____ (YES OR NO)?

7. LIST THE TITLES OF THE SOFTWARE YOU DEVELOPED AND ARE WILLING TO SHARE. PLEASE NOTE THE TYPE OF COMPUTER USED.

   _____

   _____

8. LIST ANY COMMERCIAL SOFTWARE (TITLE, PUBLISHER) YOU ARE USING TO TEACH MATH: ALSO, PLEASE NOTE THE COMPUTER USED WITH THE SOFTWARE.

---

9. WHAT OTHER RESOURCE MATERIALS ARE YOU USING TO TEACH TECHNICAL MATH?

TEXTBOOKS: (PLEASE LIST TITLE, AUTHOR, PUBLISHER)

CURRICULUM MATERIALS: (PLEASE LIST TITLE, PUBLISHER)

AUDIO - VISUAL MATERIALS: (PLEASE LIST TITLE, DEVELOPER)

OTHER MATERIALS:

NOTE: YOU MAY NEED TO ATTATCH ADDITIONAL SHEETS OF PAPER TO DESCRIBE THE RESOURCES YOU USE TO TEACH MATH.

EXIT MATH COMPETENCIES

FOR

DRAFTING

Directions: Circle the number which indicates whether or not a student needs the competency when exiting your drafting program. Please do not leave any item unanswered.

	NEEDED	NOT NEEDED
1. ADD, SUBTRACT, MULTIPLY ON A NUMBER LINE. -	1	2
2. REPRESENT THE PRODUCTS OF TWO NUMBERS ON A GRAPH. ----------	1	2
3. FIND THE VALUE OF A RADIUS VECTOR GRAPHICALLY. ----------	1	2
4. REPRESENT TRIGOMETRIC FUNCTIONS BY GRAPHING. ----------	1	2
5. DETERMINE X AND Y INTERCEPTS ON A GRAPH. --	1	2
6. SOLVE TWO SIMULTANEOUS EQUATIONS BY GRAPHING. ----------	1	2
7. CONVERT A WHOLE NUMBER TO A POSITIVE POWER OF TEN. EXAMPLE:(46 TO 4.6 X 10 = ?)	1	2
8. ADD,SUBTRACT,MULTIPLY,AND DIVIDE POSITIVE AND NEGATIVE POWERS OF TEN.EXAMPLE: $(4 \times 10^3) + (6 \times 10^3) = ?$	1	2
9. SQUARE A NUMBER. ----------	1	2
10. FIND THE SQUARE ROOT OF A NUMBER. ---------	1	2
11. SQUARE A MONOMIAL. EXAMPLE: $(2ab^3)^2 = ?$ -----	1	2
12. CUBE A MONOMIAL. EXAMPLE: $(3a^3b^2)^3 = ?$ ------	1	2
13. TAKE THE SQUARE ROOT OF A MONOMIAL.($\sqrt{4} = ?$)	1	2
14. FIND THE CUBE ROOT OF A MONOMIAL. EXAMPLE: ($\sqrt[3]{8} = ?$) ----------	1	2
15. SQUARE A BINOMIAL. EXAMPLE: $((a - b)^2 = ?$) ___	1	2
16. TAKE THE SQUARE ROOT OF A TRINOMIAL. EXAMPLE:($\sqrt{a^2 + 2ab + b^2} = ?$)----------	1	2

	NEEDED	NOT NEEDED
17. MULTIPLY AND DIVIDE NUMBERS WITH EXPONENTS. EXAMPLE: ($a^3 \times a^4 = ?$) ----------	1	2
18. MULTIPLY A NUMBER WITH AN EXPONENT BY AN EXPONENT. EXAMPLE: ($a^4)^5 = ?$ ----------	1	2
19. MULTIPLY A FRACTION WITH AN EXPONENT BY AN EXPONENT. EXAMPLE: ($x^n / y^m = ?$) -------	1	2
20. EXPRESS NUMBERS WITH NEGATIVE EXPONENTS AS NUMBERS WITH POSITIVE EXPONENTS. EXAMPLE: ($a^{-2} b^{-3} = ?$) ----------	1	2
21. FIND THE VALUES OF NUMBERS WITH FRACTIONAL EXPONENTS. EXAMPLE: (16)$^{1/2}$ = ? ----------	1	2
22. SIMPLIFY RADICALS CONTAINING FRACTIONS. EXAMPLE: ($\sqrt{5/6} = ?$)----------	1	2
23. ADD AND SUBTRACT RADICALS. EXAMPLE: ($2\sqrt{2} + 2\sqrt{3} = ?$)----------	1	2
24. GROUP TERMS IN AN EQUATION. ----------	1	2
25. DETERMINE SIGNS IN A COMPLEX EQUATION. ----	1	2
26. SOLVE EQUATIONS WITH ONE UNKNOWN. ---------	1	2
27. SOLVE EQUATIONS BY TRANSPOSING. EXAMPLE: ($e + 4 = 12$, $e = ?$) ----------	1	2
28. SOLVE AN EQUATION BY CANCELING A TERM. EXAMPLE: ($x - y = 2 - x$, $y = ?$) ---------	1	2
29. CHECK SOLUTIONS FOR EQUATIONS. ----------	1	2
30. FORM EQUATIONS FROM OBSERVED DATA. -------	1	2
31. SOLVE A PROBLEM USING A FORMULA WITH KNOWNS AND ONE UNKNOWN EXPRESSED IN THE SAME UNIT.	1	2
32. SOLVE A PROBLEM INVOLVING 2 FORMULAS, 3 OR MORE KNOWNS, AND ONE UNKNOWN. --------	1	2
33. SOLVE A PROBLEM INVOLVING 3 FORMULAS, 3 OR MORE KNOWNS, AND ONE OR MORE UNKNOWNS. ----------	1	2

	NEEDED	NOT NEEDED
34. SOLVE A QUADRADIC EQUATION. EXAMPLE:($X^2 - 25 = 0$, X = ?)----------	1	2
35. SOLVE EQUATIONS WITH THE QUADRADIC FORMULA. EXAMPLE: ($2a^2 + 2a - 6 = 0$) -------	1	2
36. SOLVE QUADRADIC EQUATIONS BY GRAPHING.EXAMPLE: ($x^2 - 10x + 16 = 0$).	1	2
37. FACTOR A SIMPLE EQUATION.	1	2
38. FIND THE PRIME FACTORS OF EQUATIONS.EXAMPLE: ($3ax^2 + 6ax + 3ay^2 = ?$).	1	2
39. FIND THE PRODUCT WITH THE DIFFERENCE AND SUM OF TWO EQUATIONS. EXAMPLE: (a + b) (a - b) = ? ----------	1	2
40. FACTOR THE SUM AND DIFFERENCE OF 2 CUBES. EXAMPLE: $\frac{b^3 + c^3}{a^3 - b^3}$ ----------	1	2
41. SOLVE SIMULTANEOUS LINEAR EQUATIONS BY ADDITION AND SUBRACTION. ----------	1	2
42. SOLVE SIMULTAEOUS LINEAR EQUATIONS BY SUBSTITUTION. ----------	1	2
43. SOLVE SIMULTANEOUS EQUATIONS BY COMPARISON. -	1	2
44. SOLVE FRACTIONAL FORM SIMULTANEOUS EQUATIONS. EXAMPLE: (x/4 + y/3 = 7/12).----------	1	2
45. DETERMINE COMPLIMENTARY AND SUPPLEMENTARY ANGLES OF A TRIANGLE. ----------	1	2
46. FIND THE ARC, SINE, COSINE AND TANGENT OF AN ANGLE. ----------	1	2
47. FIND FUNCTIONS OF ANGLES GREATER THAN 90 . -	1	2
48. FIND FUNCTIONS OF AN ANGLE IN SECOND, THIRD AND FOURTH QUADRANTS. ----------	1	2
49. SOLVE A PROBLEM INVOLVING SIMILAR RIGHT TRIANGLES. ----------	1	2
50. FIND TRIGOMETRIC RATIOS OF ANGLES OF RIGHT TRIANGLES. ----------	1	2
51. SOLVE FOR ANGLES, SIDES AND HYPOTENUSE FOR A RIGHT TRIANGLE. ----------	1	2

	NEEDED	NOT NEEDED
52. SOLVE GRAPHICALLY FOR ELEMENTS OF A RIGHT TRIANGLE.	1	2
53. SOLVE WORD PROBLEMS RELATED TO A RIGHT TRIANGLE.	1	2
54. FIND THE LEAST COMMON MULTIPLE. EXAMPLE: $6x^2y$ = ?	1	2
55. REDUCE A FRACTION TO ITS LOWEST TERM. EXAMPLE: $\frac{12x^2y^2}{24x^3y^2z}$	1	2
56. CHANGE SIGN OF FRACTIONS. EXAMPLE: $\frac{-(+a)}{-b}$ = ?	1	2
57. ADD, SUBTRACT, MULTIPLY AND DIVIDE FRACTIONS. EXAMPLE: $\frac{\frac{e^3}{4} - 4}{1 + \frac{e}{5}}$	1	2
58. CONVERT A FRACTION TO A DECIMAL.	1	2
59. EXPRESS EQUATIONS IN LOGARITHMIC FORM, EXAMPLE: (10^5 = 10,000)	1	2
60. FIND THE LOGARITHM OF A PRODUCT, EXAMPLE: LOG OF (M X N = ?)	1	2
61. FIND THE LOGARITHM OF A QUOTIENT, EXAMPLE: LOG OF $\frac{M}{N}$	1	2
62. FIND THE LOGARITHM OF A POWER, EXAMPLE: (10^3 = ?)	1	2
63. FIND THE LOGARITHM OF A ROOT, EXAMPLE: ($10^{1/3}$ = ?)	1	2
64. FIND THE LOGARITHM OF A NUMBER, EXAMPLE: (140 = ?)	1	2
65. EXPRESS EQUATIONS IN EXPONENTIAL FORM, EXAMPLE: ($\log_{10} 1 = 0$)	1	2
66. FIND THE ANTILOG OF A NUMBER, EXAMPLE: (.8782 = ?)	1	2

	NEEDED	NOT NEEDED
67. ADD LOGARITHMS.	1	2
68. SUBTRACT LOGARITHMS.	1	2
69. MULTIPLY LOGARITHMS.	1	2
70. COMPUTE LOGARITHMS WITH NEGATIVE NUMBERS.	1	2
71. DIVISION BY LOGARITHMS.	1	2
72. MULTIPLICATION AND DIVISION BY LOGARITHMS.	1	2
73. EXTRACTING ROOTS BY LOGARITHMS.	1	2
74. COMPUTE EQUATIONS USING LOGARITHMS WITH FRACTIONAL EXPONENTS. EXAMPLE: (14.3) = ?	1	2
75. GRAPH A LOGARITHM FUNCTION. EXAMPLEE:(y=log x)	1	2
76. SOLVE A LOGARITHMIC EQUATION. EXAMPLE: (log x^2 - log x = 0.3)	1	2
77. FIND THE CORRECT PROPORTIONS OF SELECTED OBJECTS.	1	2
78. DETERMINE DIMENSIONS TO SCALE.	1	2
DEFINE THE FOLLOWING.		
79. PARTS OF A CIRCLE.	1	2
80. CONCENTRIC CIRCLES.	1	2
81. ECCENTRIC CIRCLES.	1	2
82. RIGHT ANGLE.	1	2
83. ACUTE ANGLE.	1	2
84. OBTUSE ANGLE.	1	2
85. COMPLEMENTARY ANGLES.	1	2
86. SUPPLEMENTARY ANGLES.	1	2
87. CALCULATE THE AREA AND CIRCUMFERENCE OF A CIRCLE.	1	2

	NEEDED	NOT NEEDED
LIST SIDE AND OR ANGLE RELATIONSHIPS FOR THE FOLLOWING.		
88. EQUILATERAL TRIANGLE_____	1	2
89. ISOSCELES TRIANGLE._____	1	2
90. SCALENE TRIANGLE._____	1	2
91. RIGHT TRIANGLE._____	1	2
92. RIGHT TRIANGLE IN A SEMI-CIRCLE.___	1	2
LIST THE SIDE AND OR ANGLE RELATIONSHIPS FOR THE FOLLOWING:		
93. SQUARE._____	1	2
94. RECTANGLE._____	1	2
95. RHOMBUS._____	1	2
96. RHOMBOID._____	1	2
97. TRAPEZOID._____	1	2
98. TRAPEZIUM._____	1	2
LIST THE SIDE AND OR ANGLE RELATIONSHIPS FOR THE FOLLOWING:		
99. PENTAGON._____	1	2
100. HEXAGON._____	1	2
101. HEPTAGON._____	1	2
102. OCTAGON._____	1	2
103. NONAGON._____	1	2
104. DECAGON._____	1	2
105. DODECAGON._____	1	2
LIST THE SIDE AND OR ANGLE RELATIONSHIP FOR THE FOLLOWING:		
106. TETRAHEDRON._____	1	2
107. HEXAHEDRON._____	1	2

	NEEDED	NOT NEEDED
108. OCTAHEDRON.	1	2
109. DODECAHEDRON.	1	2
110. ICOSOHEDRON.	1	2
LIST SIDE AND OR ANGLE RELATIONSHIPS FOR THE FOLLOWING:		
111. RIGHT SQUARE.	1	2
112. OBLIQUE TRIANGLE.	1	2
LIST SIDE AND OR ANGLE RELATIONSHIPS FOR THE FOLLOWING:		
113. RIGHT TRIANGULAR PRISM.	1	2
114. RIGHT RECTANGULAR PRISM.	1	2
115. RIGHT PENTAGONAL PRISM.	1	2
116. OBLIQUE PENTAGONAL PRISM.	1	2
117. OBLIQUE HEXAGONAL PRISM.	1	2
LIST ELEMENTS FOR THE FOLLOWING:		
118. RIGHT CIRCULAR CYLINDER.	1	2
119. OBLIQUE CIRCULAR CYLINDER.	1	2
LIST SIDE AND OR ANGLE RELATIONSHIPS FOR THE FOLLOWING:		
120. RIGHT TRIANGULAR PYRAMID.	1	2
121. RIGHT SQUARE PYRAMID.	1	2
122. OBLIQUE PENTAGONAL PYRAMID.	1	2
LIST ELEMENTS FOR THE FOLLOWING:		
123. RIGHT CIRCULAR CONE.	1	2
124. OBLIQUE CIRCULAR CONE.	1	2
125. SPHERE.	1	2
126. TORUS.	1	2

	NEEDED	NOT NEEDED
127. DIVIDE LINES INO EQUAL DIVISIONS.	1	2
128. DETERMINE MEASUREMENTS OF ENLARGED AND REDUCED OBJECTS.	1	2
129. DETERMINE TOLERANCES AND LIMITS OF DRILL HOLES.	1	2
130. DETERMINE CLEARANCE, TRANSITION, AND INTERFERENCE FITS.	1	2
131. DETERMINE DIMENSIONS AND TOLERANCES OF AN INTERNAL AND AN EXTERNAL CYLINDRICAL SURFACE.	1	2
132. COMPUTE HORIZONTAL AND VERTICAL SPACING OF AN OBJECT.	1	2
133. CONSTRUCT A BAR GRAPH.	1	2
134. DESCRIBE INFORMATION FROM A LINE GRAPH.	1	2
135. CONSTRUCT A CIRCLE GRAPH AND PIE CHART.	1	2
136. COMPUTE DIAMETRICAL PITCH OF A THREAD.	1	2
137. COMPUTE CIRCULAR PITCH OF A THREAD.	1	2
138. COMPUTE VERTICAL SPACING, GIVEN THE WORKING SPACE AND HEIGHT OF AN OBJECT.	1	2
139. COMPUTE DIAMETRICAL PITCH OF A GEAR.	1	2
140. COMPUTE CIRCULAR PITCH OF A GEAR.	1	2
141. COMPUTE PITCH DIAMETER OF A GEAR.	1	2
142. COMPUTE OUTSIDE DIAMETER OF A GEAR.	1	2
143. COMPUTE ROOT DIAMETER OF A GEAR.	1	2
144. COMPUTE ADDENDUM OF A GEAR.	1	2
145. COMPUTE DEDENDUM OF A GEAR.	1	2
146. CALCULATE WHOLE DEPTH USING A FORMULA.	1	2
147. COMPUTE CIRCULAR THICKNESS OF A GEAR.	1	2
148. DETERMINE METRIC NUMBERS THAT REPRESENT THE SI PREFIX SYMBOLS.	1	2

	NEEDED	NOT NEEDED
149. DETERMINE METRIC PREFIX NAMES FOR PREFIX SYMBOLS.	1	2
150. FIND THE EQUIVALENT VALUE IN METRICS OF A VALUE WITH A PREFIX SYMBOL.	1	2
151. DETERMINE CUSTOMARY LENGTHS FOR SELECTED METRIC LENGTHS.	1	2
152. CONVERT UNITS IN THE METRIC SYSTEM,EXAMPLE: (M to mm).	1	2
153. CONVERT LENGTHS FROM ENGLISH TO METRIC.	1	2
154. CALCULATE AREAS OF OBJECTS IN THE METRIC SYSTEM.	1	2
155. CONVERT LENGTHS FROM METRIC TO ENGLISH.	1	2
156. CONVERT DIMENSIONS OF OBJECTS FROM ENGLISH TO METRIC.	1	2
157. CONVERT AREAS MEASUREMENTS TO METRIC AREAS.	1	2
158. COMPUTE METRIC VOLUMES.	1	2
159. CONVERT CUSTOMARY DIMENSIONS TO METRIC DIMENSIONS AND CALCULATE THE VOLUME IN METRIC UNITS.	1	2
FIND THE CORRECT DRAFTING SCALE RATIO IN METRICS FOR:		
160. ASSEMBLY DRAWINGS.	1	2
161. DETAIL DRAWINGS.	1	2
162. WORKING DRAWINGS.	1	2
163. SITE PLANS.	1	2
164. SURVEYS.	1	2
165. MAPS.	1	2

PLEASE ADD ADDITIONAL COMPETENCIES YOU BELIEVE ARE NEEDED.

166. _____

167. _____

EXIT MATH COMPETENCIES

FOR

ELETRICITY AND ELECTRONICS

Directions: Circle the number which indicates whether or not a student needs the competency when exiting your basic electronics program. Please do not leave any item unanswered.

		NEEDED	NOT NEEDED
1.	ADD, SUBTRACT, MULTIPLY ON A NUMBER LINE. -	1	2
2.	REPRESENT THE PRODUCTS OF TWO NUMBERS ON A GRAPH. ----------	1	2
3.	FIND THE VALUE OF A RADIUS VECTOR GRAPHICALLY. ----------	1	2
4.	REPRESENT TRIGOMETRIC FUNCTIONS BY GRAPHING. ----------	1	2
5.	DETERMINE X AND Y INTERCEPTS ON A GRAPH. --	1	2
6.	SOLVE TWO SIMULTANEOUS EQUATIONS BY GRAPHING. ----------	1	2
7.	CONVERT A WHOLE NUMBER TO A POSITIVE POWER OF TEN. EXAMPLE:(46 = 4.6 X ?)_____	1	2
8.	ADD,SUBTRACT,MULTIPLY,AND DIVIDE POSITIVE AND NEGATIVE POWERS OF TEN.EXAMPLE: $(4\times10^{3})+(6\times10^{3}) = ?$	1	2
9.	SQUARE A NUMBER. ----------	1	2
10.	FIND THE SQUARE ROOT OF A NUMBER. ----------	1	2
11.	SQUARE A MONOMIAL. EXAMPLE: $(2ab^{2})^{2} = ?$ ----	1	2
12.	CUBE A MONOMIAL. EXAMPLE: $(3a^{2}b^{2})^{3} = ?$ -----	1	2
13.	TAKE THE SQUARE ROOT OF A MONOMIAL.($\sqrt{4} = ?$)	1	2
14.	FIND THE CUBE ROOT OF A MONOMIAL. EXAMPLE: ($\sqrt[3]{-8} = ?$) ----------	1	2
15.	SQUARE A BINOMIAL. EXAMPLE: $(a - b)^{2} = ?$ ---	1	2
16.	TAKE THE SQUARE ROOT OF A TRINOMIAL. EXAMPLE:($\sqrt{a^{2} + 2ab + b^{2}} = ?$) ----------	1	2

	NEEDED	NOT NEEDED
17. MULTIPLY AND DIVIDE NUMBERS WITH EXPONENTS. EXAMPLE: $(a^3 \times a^4) = ?$ ---------	1	2
18. MULTIPLY A NUMBER WITH AN EXPONENT BY AN EXPONENT. EXAMPLE: $(a^4)^5 = ?$ ----------	1	2
19. MULTIPLY A FRACTION WITH AN EXPONENT BY AN EXPONENT. EXAMPLE: $(x^n / y^m) = ?$ -------	1	2
20. EXPRESS NUMBERS WITH NEGATIVE EXPONENTS AS NUMBERS WITH POSITIVE EXPONENTS. EXAMPLE: $(a^{-2}b^{-3}) = ?$ ----------	1	2
21. FIND THE VALUES OF NUMBERS WITH FRACTIONAL EXPONENTS. EXAMPLE: $(16)^{1/2} = ?$ ----------	1	2
22. SIMPLIFY RADICALS CONTAINING FRACTIONS. EXAMPLE: $(\sqrt{5/6}) = ?$ ----------	1	2
23. ADD AND SUBTRACT RADICALS. EXAMPLE: $(2\sqrt{2} + 2\sqrt{3}) = ?$ ----------	1	2
24. GROUP TERMS IN AN EQUATION. ----------	1	2
25. DETERMINE SIGNS IN A COMPLEX EQUATION. ----	1	2
26. SOLVE EQUATIONS WITH ONE UNKNOWN. ---------	1	2
27. SOLVE EQUATIONS BY TRANSPOSING. EXAMPLE: $(e + 4) = 12$, $e = ?$ ----------	1	2
28. SOLVE AN EQUATION BY CANCELING A TERM. EXAMPLE: $(x - y = 2 - x)$, $y = ?$ ----------	1	2
29. CHECK SOLUTIONS FOR EQUATIONS. ----------	1	2
30. FORM EQUATIONS FROM OBSERVED DATA. -------	1	2
31. SOLVE A PROBLEM USING A FORMULA WITH KNOWNS AND ONE UNKNOWN EXPRESSED IN THE SAME UNIT. EXAMPLE: A PROBLEM ABOUT OHMS LAW. ----------	1	2
32. SOLVE A PROBLEM INVOLVING 2 FORMULAS, 3 OR MORE KNOWNS, AND ONE UNKNOWN. --------	1	2
33. SOLVE A PROBLEM INVOLVING 3 FORMULAS, 3 OR MORE KNOWNS, AND ONE OR MORE UNKNOWNS. ----------	1	2

	NEEDED	NOT NEEDED
34. SOLVE A QUADRADIC EQUATION. EXAMPLE: ($x^2 - 25 = 0$) $x = ?$ ----------	1	2
35. SOLVE EQUATIONS WITH THE QUADRADIC FORMULA. (EXAMPLE: $2a^2 + 2a - 6 = 0$) ------	1	2
36. SOLVE QUADRADIC EQUATIONS BY GRAPHING.EXAMPLE: $(x^2 - 10x + 16 = 0) = ?$	1	2
37. FACTOR A SIMPLE EQUATION.	1	2
38. FIND THE PRIME FACTORS OF EQUATIONS.EXAMPLE: $(3ax^2 + 6ax + 3ay^2) = ?$	1	2
39. FIND THE PRODUCT WITH THE DIFFERENCE AND SUM OF TWO EQUATIONS. EXAMPLE: (a + b) (a - b) = ? ----------	1	2
40. FACTOR THE SUM AND DIFFERENCE OF 2 CUBES. EXAMPLE: $\frac{b^3 + c^3 = ?}{a^3 - b^3 = ?}$ ----------	1	2
41. SOLVE SIMULTANEOUS LINEAR EQUATIONS BY ADDITION AND SUBRACTION. ----------	1	2
42. SOLVE SIMULTAEOUS LINEAR EQUATIONS BY SUBSTITUTION. ----------	1	2
43. SOLVE SIMULTANEOUS EQUATIONS BY COMPARISON. -	1	2
44. SOLVE FRACTIONAL FORM SIMULTANEOUS EQUATIONS. EXAMPLE: (x/4 + y/3 = 7/12).----------	1	2
45. DETERMINE COMPLIMENTARY AND SUPPLEMENTARY ANGLES OF A TRIANGLE. ----------	1	2
46. FIND THE ARC, SINE, COSINE AND TANGENT OF AN ANGLE. ----------	1	2
47. FIND FUNCTIONS OF ANGLES GREATER THAN 90 . -	1	2
48. FIND FUNCTIONS OF AN ANGLE IN SECOND, THIRD AND FOURTH QUADRANTS. ----------	1	2
49. SOLVE A PROBLEM INVOLVING SIMILAR RIGHT TRIANGLES. ----------	1	2
50. FIND TRIGOMETRIC RATIOS OF ANGLES OF RIGHT TRIANGLES. ----------	1	2
51. SOLVE FOR ANGLES, SIDES AND HYPOTENUSE FOR A RIGHT TRIANGLE. ----------	1	2

	NEEDED	NOT NEEDED
52. SOLVE GRAPHICALLY FOR ELEMENTS OF A RIGHT TRIANGLE. ----------	1	2
53. SOLVE WORD PROBLEMS RELATED TO A RIGHT TRIANGLE. ----------	1	2
54. FIND THE LEAST COMMON MULTIPLE. EXAMPLE: $(6\ x^2y\ ) = ?$ ----------	1	2
55. REDUCE A FRACTION TO ITS LOWEST TERM. EXAMPLE: $\frac{12x^2y^2}{24x^3y^2z} = ?$ ----------	1	2
56. CHANGE SIGN OF FRACTIONS. EXAMPLE: $\frac{(+a)}{-b} = ?$ ---	1	2
57. ADD, SUBTRACT, MULTIPLY AND DIVIDE FRACTIONS. EXAMPLE: $\frac{\frac{e^3}{4} - 4}{1 + \frac{e}{5}} = ?$ ----------	1	2
58. CONVERT A FRACTION TO A DECIMAL. ----------	1	2
59. SET UP EQUATIONS FROM THEORY. EXAMPLE: KIRCHOFFS LAW ----------	1	2
60. EXPRESS EQUATIONS IN LOGARITMIC FORM, EXAMPLE: (10^5=10,000). ----------	1	2
61. FIND THE LOGARITHM OF A PRODUCT, EXAMPLE: LOG OF (M X N) =? ----------	1	2
62. FIND THE LOGARITHM OF A QUOTIENT, EXAMPLE: $(\text{LOG } \frac{a}{n} = \frac{m}{n})$ ----------	1	2
63. FIND THE LOGARITHM OF A POWER, EXAMPLE: $(10^3) = ?$	1	2
64. FIND THE LOGARITHM OF A ROOT, EXAMPLE: $(10^{1/3}) = ?$	1	2
65. FIND THE LOGARITHM OF A NUMBER, EXAMPLE: (140)= ?	1	2
66. EXPRESS EQUATIONS IN EXPONENTIAL FORM, EXAMPLE: $(\text{LOG}_{10}\ 1 = 0)$ ----------	1	2

67. FIND THE ANTILOG OF A NUMBER, EXAMPLE:(.8782) = ? 1 2

68. ADD LOGARITHMS. _____ 1 2

69. SUBTRACT LOGARITHMS._____ 1 2

70. MULTIPLY LOGARITHMS. _____ 1 2

71. COMPUTE LOGARITHMS WITH NEGATIVE NUMBERS._____ 1 2

72. DIVISION BY LOGARITHMS. _____ 1 2

73. MULTIPLICATION AND DIVISION BY LOGARITHMS._____ 1 2

74. EXTRACTING ROOTS BY LOGARITHMS. _____ 1 2

75. COMPUTE EQUATIONS USING LOGARITHMS WITH FRACTIONAL EXPONENTS. EXAMPLE: $(14.3)^{1/3} = ?$ _____ 1 2

76. GRAPH A LOGARITHM FUNCTION. EXAMPLE:($y=\log_{10} x$)__ 1 2

77. SOLVE A LOGARITHMIC EQUATION. EXAMPLE: ($\log x^2 - \log x = 0.3$) _____ 1 2

78. SOLVE ELECTRONIC PROBLEMS USING LOGARITHMS. EXAMPLE: $q = CE\left(1 - E^{\frac{-t}{CR}}\right)$ _____ 1 2

79. EXPRESS GAIN OR LOSS OF APPARATUS IN DECIBELS, (LOGARITHMS). EXAMPLE: $20 = 10 \log \frac{p_2}{6}$ _____ 1 2

80. EXPRESS GAIN OF LOSS OF QUANTITIES IN DECIBELS, (LOGARITHMS). _____ 1 2

81. FIND THE INDUCTANCE OF A LINE USING LOGARITHMS. 1 2

82. FIND THE IMPEDANCE OF A LINE USING LOGARITHMS. 1 2

83. FIND THE CAPACITANCE OF A LINE USING LOGARITHMS. 1 2

84. GRAPH THE EQUATION ($y = \sin x$). _____ 1 2

85. GRAPH THE COSINE CURVE. EXAMPLE: ($y = \cos x$). 1 2

86. IN EQUATIONS OF PERIODIC CURVES, SPECIFY FREQUENCY._____ 1 2

87. IN EQUATIONS OF PERIODIC CURVES, SPECIFY ANGLE OF VELOCITY. _____ 1 2

88.	IN EQUATIONS OF PERIODIC CURVES, SPECIFY THE AMPLITUDE.	1	2
89.	IN EQUATIONS OF PERIODIC CURVES, SPECIFY PERIOD.	1	2
90.	IN EQUATIONS OF PERIODIC CURVES,SPECIFY ANGLE OF LEAD OR LAG.	1	2
91.	FIND THE MAGNITUDE AND DIRECTION OF VECTORS.	1	2
92.	FIND THE HORIZONTAL AND VERTICAL COMPONENTS OF VECTORS.	1	2
93.	FIND THE RESULTANT FORCES OF VECTORS.	1	2
94.	USE VECTOR DIAGRAMS TO FIND INSTANTANEOUS VALUES IN AN AC CIRCUIT.	1	2
95.	DETERMINE ANGLES IN A VECTOR DIAGRAM OF AN AC CIRCUIT.	1	2
96.	FIND THE ANGULAR VELOCITY OF AN AC CIRCUIT.	1	2
97.	WRITE EQUATIONS FOR VOLTAGE AND CURRENT USING AN AC CIRCUIT.	1	2
98.	DRAW VECTOR DIAGRAMS OF CIRCUITS, AND CONSTRUCT VECTORS FOR AC CIRCUITS.	1	2
99.	DETERMINE ANGLES IN A VECTOR DIAGRAM AND PLOT IMAGINARY NUMBERS ON A VECTOR DIAGRAM.	1	2
100.	EXPRESS AC CIRCUIT PARAMETERS IN POLAR FORM.	1	2
101.	CONVERT AC CIRCUIT PARAMETERS FROM RECTANGULAR TO POLAR FORM AND VICE VERSA.	1	2
102.	SOLVE PROBLEMS USING PARAMETERS EXPRESSED IN RECTANGULAR.	1	2
103.	SOLVE PROBLEMS USING PARAMETERS EXPRESSED IN POLAR FORM.	1	2
104.	ADD VECTORS IN RECTANGULAR FORM.	1	2
105.	SUBTRACT VECTORS IN RECTANGULAR FORM.	1	2
106.	MULTIPLY VECTORS IN RECTANGULAR FORM.	1	2
107.	DIVIDE VECTORS IN RECTANGULAR FORM.	1	2
108.	MULTIPLY POLAR VECTORS.	1	2

109. DIVIDE POLAR VECTORS. _____ 1 2

110. EXPRESS NUMBERS IN THE BINARY NUMBER SYSTEM._____ 1 2

111. CONSTRUCT AND ANALYZE TRUTH TABLES._____ 1 2

112. DEVELOP A BOOLEAN EQUATION FROM A LOGIC DIAGRAM.__ 1 2

113. USE THE SUM OF PRODUCTS METHOD TO SOLVE A BOOLEAN EQUATION._____ 1 2

114. DEVELOP A SUM - OF - PRODUCTS EQUATION FROM A TRUTH TABLE._____ 1 2

115. SIMPLIFY A BOOLEAN EQUATION._____ 1 2

116. CONVERT A TRUTH TABLE INTO A KARNOUGH MAP._____ 1 2

117. DRAW A THREE AND FOUR VARIABLE KARNOUGH MAP FROM A TRUTH TABLE._____ 1 2

118. SIMPLIFY A KARNOUGH MAP BY USING OCTETS,QUADS, OR PAIRS._____ 1 2

119. USE THE PRODUCT OF SUMS METHOD TO SIMPLIFY A A TRUTH TABLE._____ 1 2

120. CONVERT A TRUTH TABLE TO AN EQUATION._____ 1 2

121. SIMPLIFY A PRODUCT OF SUMS EQUATION._____ 1 2

122. USE MULTIPLEXER LOGIC._____ 1 2

123. FIND BCD EQUIVALENTS OF DECIMAL NUMBERS._____ 1 2

124. CONVERT BINARY NUMBERS TO DECIMAL EQUIVALENTS.____ 1 2

125. CONVERT OCTAL NUMBERS TO DECIMAL EQUIVALENTS._____ 1 2

126. FIND THE DECIMAL EQUIVALENT OF AN OCTAL NUMBER.___ 1 2

127. CONVERT HEXADECIMAL NUMBERS TO BINARY NUMBERS.____ 1 2

128. EXPRESS A DECIMAL NUMBER IN EXCESS - 3 CODE._____ 1 2

129. EXPRESS AN EXCESS - 3 NUMBER AS A DECIMAL EQUIVALENT._____ 1 2

130. CONVERT GRAY NUMBERS TO A DECIMAL EQUIVALENT._____ 1 2

131. GIVE THE SUM OF NUMBERS IN BASE 8 OR 16._____ 1 2

132. SUM OF BINARY NUMBERS._____ 1 2

133. ADD WHOLE NUMBERS IN BASE 10 USING 16 BIT NUMBERS. 1 2

134. SUBTRACT BINARY NUMBERS._____ 1 2

135. SUBTRACT WHOLE NUMBERS IN THE BASE TEN SYSTEM._____ 1 2

136. DETERMINE OVERFLOW OF PROBLEMS WITH 8 BIT UNSIGNED ARITHMETIC._____ 1 2

137. EXPRESS POSITIVE OR NEGATIVE WHOLE NUMBERS IN 8 BIT SIGN MAGNITUDE FORM._____ 1 2

138. CONVERT SIGN MAGNITUDE NUMBERS INTO DECIMAL EQUIVALENTS._____ 1 2

139. EXPRESS THE COMPLEMENT OF NUMBERS IN HEXADECIMAL NOTATION._____ 1 2

140. EXPRESS THE 2'S COMPLEMENT OF BINARY NUMBERS._____ 1 2

141. CONVERT POSITIVE OR NEGATIVE WHOLE NUMBERS TO 2'S COMPLEMENT REPRESENTATION._____ 1 2

142. SHOW THE 8 BIT ADDITION AND SUBTRACTION OF DECIMAL NUMBERS IN 2'S COMPLEMENT REPRESENTATION._____ 1 2

PLEASE ADD COMPETENCIES YOU BELIEVE ARE NECESSARY TO EXIT FROM YOUR PROGRAM.

143. _____
_____

144. _____
_____

145. _____
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146. _____
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147. _____
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148. _____
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149. _____
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150 _____
_____

EXIT MATH COMPETENCIES

FOR

MACHINE SHOP

Directions: Circle the number which indicates whether or not a student needs the competency when exiting your basic machine shop program. Please do not leave any item unanswered.

	NEEDED	NOT NEEDED
1. ADD, SUBTRACT, MULTIPLY ON A NUMBER LINE. -	1	2
2. REPRESENT THE PRODUCTS OF TWO NUMBERS ON A GRAPH. ----------	1	2
3. FIND THE VALUE OF A RADIUS VECTOR GRAPHICALLY. ----------	1	2
4. REPRESENT TRIGOMETRIC FUNCTIONS BY GRAPHING. ----------	1	2
5. DETERMINE X AND Y INTERCEPTS ON A GRAPH. --	1	2
6. SOLVE TWO SIMULTANEOUS EQUATIONS BY GRAPHING. ----------	1	2
7. CONVERT A WHOLE NUMBER TO A POSITIVE POWER OF TEN. EXAMPLE:(46 = 4.6 X ?)_____	1	2
8. ADD,SUBTRACT,MULTIPLY,AND DIVIDE POSITIVE AND NEGATIVE POWERS OF TEN.EXAMPLE: $(4\times10^{3})+(6\times10^{3})$ = ?	1	2
9. SQUARE A NUMBER. ----------	1	2
10. FIND THE SQUARE ROOT OF A NUMBER. ---------	1	2
11. SQUARE A MONOMIAL. EXAMPLE: $(2ab^{2})^{2}$ = ? ----	1	2
12. CUBE A MONOMIAL. EXAMPLE: $(3a^{3}b^{2})^{3}$ = ? -----	1	2
13. TAKE THE SQUARE ROOT OF A MONOMIAL.($\sqrt{4}$ = ?)	1	2
14. FIND THE CUBE ROOT OF A MONOMIAL. EXAMPLE: ($\sqrt[3]{-8}$ = ?) ----------	1	2
15. SQUARE A BINOMIAL. EXAMPLE: $(a - b)^{2}$ = ? ---	1	2
16. TAKE THE SQUARE ROOT OF A TRINOMIAL. EXAMPLE:($\sqrt{a^{2} + 2ab + b^{2}}$ = ?) ----------	1	2

	NEEDED	NOT NEEDED
17. MULTIPLY AND DIVIDE NUMBERS WITH EXPONENTS. EXAMPLE: $(a^3 \times a^4) = ?$ ---------	1	2
18. MULTIPLY A NUMBER WITH AN EXPONENT BY AN EXPONENT. EXAMPLE: $(a^4)^5 = ?$ ----------	1	2
19. MULTIPLY A FRACTION WITH AN EXPONENT BY AN EXPONENT. EXAMPLE: $(x^n / y^m) = ?$ -------	1	2
20. EXPRESS NUMBERS WITH NEGATIVE EXPONENTS AS NUMBERS WITH POSITIVE EXPONENTS. EXAMPLE: $(a^{-2}b^{-3}) = ?$ ----------	1	2
21. FIND THE VALUES OF NUMBERS WITH FRACTIONAL EXPONENTS. EXAMPLE: $(16)^{1/2} = ?$ ----------	1	2
22. SIMPLIFY RADICALS CONTAINING FRACTIONS. EXAMPLE: $(\sqrt{5/6}) = ?$ ----------	1	2
23. ADD AND SUBTRACT RADICALS. EXAMPLE: $(2\sqrt{2} + 2\sqrt{3}) = ?$ ----------	1	2
24. GROUP TERMS IN AN EQUATION. ----------	1	2
25. DETERMINE SIGNS IN A COMPLEX EQUATION. ----	1	2
26. SOLVE EQUATIONS WITH ONE UNKNOWN. ---------	1	2
27. SOLVE EQUATIONS BY TRANSPOSING. EXAMPLE: $(e + 4) = 12, e = ?$ ----------	1	2
28. SOLVE AN EQUATION BY CANCELING A TERM. EXAMPLE: $(x - y = 2 - x), y = ?$ ----------	1	2
29. CHECK SOLUTIONS FOR EQUATIONS. ----------	1	2
30. FORM EQUATIONS FROM OBSERVED DATA. -------	1	2
31. SOLVE A PROBLEM USING A FORMULA WITH KNOWNS AND ONE UNKNOWN EXPRESSED IN THE SAME UNIT. ----------	1	2
32. SOLVE A PROBLEM INVOLVING 2 FORMULAS, 3 OR MORE KNOWNS, AND ONE UNKNOWN. --------	1	2
33. SOLVE A PROBLEM INVOLVING 3 FORMULAS, 3 OR MORE KNOWNS, AND ONE OR MORE UNKNOWNS. ----------	1	2

	NEEDED	NOT NEEDED
34. SOLVE A QUADRADIC EQUATION. EXAMPLE:($x^2 - 25 = 0$) x = ? ----------	1	2
35. SOLVE EQUATIONS WITH THE QUADRADIC FORMULA. (EXAMPLE: $2a^2 + 2a - 6 = 0$) ------	1	2
36. SOLVE QUADRADIC EQUATIONS BY GRAPHING.EXAMPLE: $(x^2 - 10x + 16 = 0) = ?$	1	2
37. FACTOR A SIMPLE EQUATION.	1	2
38. FIND THE PRIME FACTORS OF EQUATIONS.EXAMPLE: $(3ax^2 + 6ax + 3ay^2) = ?$	1	2
39. FIND THE PRODUCT WITH THE DIFFERENCE AND SUM OF TWO EQUATIONS. EXAMPLE: (a + b) (a - b) = ? ----------	1	2
40. FACTOR THE SUM AND DIFFERENCE OF 2 CUBES. EXAMPLE: $\frac{b^3 + c^3 = ?}{a^3 - b^3 = ?}$ ----------	1	2
41. SOLVE SIMULTANEOUS LINEAR EQUATIONS BY ADDITION AND SUBRACTION. ----------	1	2
42. SOLVE SIMULTAEOUS LINEAR EQUATIONS BY SUBSTITUTION. ----------	1	2
43. SOLVE SIMULTANEOUS EQUATIONS BY COMPARISON. -	1	2
44. SOLVE FRACTIONAL FORM SIMULTANEOUS EQUATIONS. EXAMPLE: (x/4 + y/3 = 7/12).----------	1	2
45. DETERMINE COMPLIMENTARY AND SUPPLEMENTARY ANGLES OF A TRIANGLE. ----------	1	2
46. FIND THE ARC, SINE, COSINE AND TANGENT OF AN ANGLE. ----------	1	2
47. FIND FUNCTIONS OF ANGLES GREATER THAN 90 . -	1	2
48. FIND FUNCTIONS OF AN ANGLE IN SECOND, THIRD AND FOURTH QUADRANTS. ----------	1	2
49. SOLVE A PROBLEM INVOLVING SIMILAR RIGHT TRIANGLES. ----------	1	2
50. FIND TRIGOMETRIC RATIOS OF ANGLES OF RIGHT TRIANGLES. ----------	1	2
51. SOLVE FOR ANGLES, SIDES AND HYPOTENUSE FOR A RIGHT TRIANGLE. ----------	1	2

	NEEDED	NOT NEEDED
52. SOLVE GRAPHICALLY FOR ELEMENTS OF A RIGHT TRIANGLE. ----------	1	2
53. SOLVE WORD PROBLEMS RELATED TO A RIGHT TRIANGLE. ----------	1	2
54. FIND THE LEAST COMMON MULTIPLE. EXAMPLE: $(6x^2y) = ?$ ----------	1	2
55. REDUCE A FRACTION TO ITS LOWEST TERM. EXAMPLE: $\frac{12x^2y^2}{24x^3y^4z} = ?$ ----------	1	2
56. CHANGE SIGN OF FRACTIONS. EXAMPLE: $\frac{(+a)}{-b} = ?$ ---	1	2
57. ADD, SUBTRACT, MULTIPLY AND DIVIDE FRACTIONS. EXAMPLE: $\frac{\frac{e^3}{4} - 4}{1 + \frac{e}{5}} = ?$ ----------	1	2
58. CONVERT A FRACTION TO A DECIMAL. ----------	1	2
59. SET UP EQUATIONS FROM THEORY. ----------	1	2
60. EXPRESS EQUATIONS IN LOGARITMIC FORM, EXAMPLE: ($10^5 = 10,000$). ----------	1	2
61. FIND THE LOGARITHM OF A PRODUCT, EXAMPLE: LOG OF (M X N) =? ----------	1	2
62. FIND THE LOGARITHM OF A QUOTIENT, EXAMPLE: $(\log \frac{a}{n} = \frac{m}{n})$ ----------	1	2
63. FIND THE LOGARITHM OF A POWER, EXAMPLE: $(10) = ?$	1	2
64. FIND THE LOGARITHM OF A ROOT, EXAMPLE: $(10) = ?$	1	2
65. FIND THE LOGARITHM OF A NUMBER, EXAMPLE: $(140) = ?$	1	2
66. EXPRESS EQUATIONS IN EXPONENTIAL FORM, EXAMPLE: ($\log_{10} 1 = 0$) ----------	1	2

67.	FIND THE ANTILOG OF A NUMBER, EXAMPLE:(.8782) = ?	1	2
68.	ADD LOGARITHMS.	1	2
69.	SUBTRACT LOGARITHMS.	1	2
70.	MULTIPLY LOGARITHMS.	1	2
71.	COMPUTE LOGARITHMS WITH NEGATIVE NUMBERS.	1	2
72.	DIVISION BY LOGARITHMS.	1	2
73.	MULTIPLICATION AND DIVISION BY LOGARITHMS.	1	2
74.	EXTRACTING ROOTS BY LOGARITHMS.	1	2
75.	COMPUTE EQUATIONS USING LOGARITHMS WITH FRACTIONAL EXPONENTS. EXAMPLE: $(14.3)^{1/3} = ?$	1	2
76.	GRAPH A LOGARITHM FUNCTION. EXAMPLE:($y=\log_{10} x$)	1	2
77.	SOLVE A LOGARITHMIC EQUATION. EXAMPLE: ($\log x^2 - \log x = 0.3$)	1	2
78.	CONVERT FROM ENGLISH UNITS TO METRIC UNITS AND VICE VERSA.	1	2
79.	DETERMINE TOLERANCE FOR A MEASUREMENT.	1	2
80.	FIND THE CIRCUMFERENCE FOR A CIRCLE.	1	2
81.	FIND THE PERIMETER OF ANY POLYGON.	1	2
82.	FIND THE AREA OF A CIRCLE.	1	2
83.	FIND THE PITCH OF A SCREW.	1	2
84.	FIND THE CUTTING SPEED, GIVEN THE REVOLUTIONS OF THE LATHE PER MINUTE, AND THE DIAMETER.	1	2
85.	SOLVE PROBLEMS USING PERCENTAGES.	1	2
86.	READ A MICROMETER.	1	2
87.	READ A VERNIER CALIPER.	1	2
88.	READ A VERNIER PROTRACTOR.	1	2
89.	SUBTRACT WITH DEGREES, MINUTES, AND SECONDS.	1	2
90.	FIND DECIMAL EQUIVALENTS OF MINUTES AND SECONDS.	1	2

91.	FIND MINUTE AND SECOND EQUIVALENTS OF DECIMALS.	1	2
92.	DETERMINE SIZES OF ANGLES ON DRAWINGS.	1	2
93.	FIND THE AREA OF A CIRCLE, TRIANGLE. SQUARE, PARALLELOGRAM AND RECTANGLE.	1	2
94.	FIND THE DIAGONAL OF A SQUARE.	1	2
95.	FIND THE DISTANCE ACROSS THE FLATS OR CORNERS IN A HEXAGON.	1	2
96.	USE A TABLE OF NATURAL FUNCTIONS TO FIND A FUNCTION OF AN ANGLE.	1	2
97.	INTERPOLATE TO FIND VALUES OF ANGLE FUNCTIONS FOR MINUTES.	1	2
98.	USE THE LAW OF SINES TO SOLVE AN OBLIQUE TRIANGLE.	1	2
99.	USE THE LAW OF COSINES TO SOLVE AN OBLIQUE TRIANGLE.	1	2
100.	DETERMINE THE AMOUNT OF TAPER.	1	2
101.	DETERMINE THE AMOUNT OF OFFSET NEEDED TO PRODUCE A GIVEN TAPER.	1	2
102.	CONVERT TAPER MEASUREMENTS TO ANGLE MEASUREMENTS.	1	2
103.	DETERMINE THE AMOUNT OF ERROR IN A GIVEN TAPER.	1	2
104.	USE A GENERAL SPEED FORMULA FOR TWO GEARS IN MESH TO SOLVE PROBLEMS.	1	2
105.	SOLVE PROBLEMS INVOLVING SIMPLE AND COMPOUND GEAR TRAINS.	1	2
106.	SOLVE PROBLEMS INVOLVING WORM GEARING.	1	2
107.	FIND THE rpm OF A TOOL, KNOWING THE CUTTING SPEED AND DIAMETER.	1	2
108.	CALCULATE DRILL SPEEDS.	1	2
109.	FIND THE RATE OF SPEED FOR LATHE TOOLS.	1	2
110.	DETERMINE A CUTTING TIME FOR LATHE AND MILLING OPERATIONS.	1	2
111.	FIND THE PITCH OF A THREAD.	1	2
112.	MEASURE A SCREW THREAD.	1	2
113.	DETERMINE OUTSIDE DIAMETERS AND TAP DRILL SIZES		

FOR MACHINE SCREWS._____ 1 2

114. FIND THE OUTSIDE DIAMETER OF A GEAR, KNOWING THE NUMBER OF TEETH AND DIAMETRICAL PITCH._____ 1 2

115. FIND THE CENTER TO CENTER DISTANCE TOR TWO MESHING SPUR GEARS._____ 1 2

116. DESIGN A GEAR TRAIN._____ 1 2

117. USE CONTINUED FRACTIONS TO CONVERT SPEED RATIO'S INTO GEAR COMBINATIONS._____ 1 2

118. CONVERT METRIC MODULE TO DIAMETRICAL PITCH._____ 1 2

119. DETERMINE THE NUMBER OF TURNS ON A DIVIDING HEAD FOR INDEXING._____ 1 2

120. INDEX FOR DEGREES. MINUTES. AND SECONDS._____ 1 2

PLEASE ADD COMPETENCIES YOU BELIEVE ARE NECESSARY TO EXIT FROM YOUR PROGRAM ON THE NEXT PAGE.

121. _____

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122. _____

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123. _____

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124. _____

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125. _____

Appendix 4

Tabulations of Survey Responses

ITEM ANALYSIS OF EXIT MATH COMPETENCIES FOR DRAFTING (N=12)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	9	3	46.	12	0	91.	12	0
2.	10	2	47.	10	2	92.	12	0
3.	10	2	48.	11	1	93.	12	0
4.	8	4	49.	12	0	94.	12	0
5.	11	1	50.	10	2	95.	11	1
6.	6	6	51.	12	0	96.	11	1
7.	9	3	52.	8	4	97.	10	2
8.	7	5	53.	12	0	98.	9	3
9.	11	1	54.	5	7	99.	12	0
10.	10	2	55.	9	3	100.	12	0
11.	8	4	56.	7	5	101.	9	3
12.	8	4	57.	9	3	102.	12	0
13.	7	5	58.	12	0	103.	7	5
14.	7	5	59.	5	7	104.	7	5
15.	7	5	60.	3	9	105.	7	5
16.	7	5	61.	3	9	106.	5	7
17.	10	2	62.	2	10	107.	6	6
18.	8	4	63.	2	10	108.	5	7
19.	8	4	64.	2	10	109.	5	7
20.	8	4	65.	2	10	110.	6	6
21.	7	5	66.	2	10	111.	10	2
22.	7	5	67.	2	10	112.	11	1
23.	7	5	68.	2	10	113.	6	6
24.	11	1	69.	2	10	114.	6	6
25.	8	4	70.	2	10	115.	6	6
26.	11	1	71.	2	10	116.	6	6
27.	11	1	72.	2	10	117.	6	6
28.	11	1	73.	2	10	118.	9	3
29.	11	1	74.	2	10	119.	8	4
30.	9	3	75.	2	10	120.	7	5
31.	11	1	76.	2	10	121.	7	5
32.	9	3	77.	12	0	122.	6	6
33.	6	6	78.	12	0	123.	8	4
34.	8	4	79.	12	0	124.	8	4
35.	7	5	80.	12	0	125.	8	4
36.	5	7	81.	12	0	126.	6	6
37.	8	4	82.	12	0	127.	12	0
38.	6	6	83.	12	0	128.	12	0
39.	8	4	84.	12	0	129.	12	0
40.	6	6	85.	12	0	130.	12	0
41.	7	5	86.	12	0	131.	12	0
42.	7	5	87.	12	0	132.	12	0
43.	7	5	88.	12	0	133.	11	1
44.	7	5	89.	12	0	134.	11	1
45.	12	0	90.	12	0	135.	11	1

Item Analysis of Exit Math Competencies for Drafting (N=12) (continued)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
136.	10	2	146.	11	1	156.	11	1
137.	10	2	147.	12	0	157.	11	1
138.	12	0	148.	11	1	158.	12	0
139.	12	0	149.	12	0	159.	11	1
140.	12	0	150.	12	0	160.	12	0
141	12	0	151.	11	1	161.	12	0
142.	12	0	152.	12	0	162.	12	0
143.	12	0	153.	11	1	163.	11	1
144.	12	0	154.	12	0	164.	10	2
145.	12	0	155.	11	1	165.	10	2

ITEM ANALYSIS OF EXIT MATH COMPETENCIES FOR ELECTRICITY (N = 12)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	11	1	46.	10	2	91.	9	3
2.	8	4	47.	9	3	92.	9	3
3.	8	4	48.	7	5	93.	9	3
4.	4	8	49.	9	3	94.	8	4
5.	8	4	50.	8	4	95.	8	4
6.	5	7	51.	10	2	96.	6	6
7.	10	2	52.	7	5	97.	11	1
8.	8	4	53.	9	3	98.	9	3
9.	12	0	54.	8	4	99.	7	5
10.	12	0	55.	5	7	100.	5	7
11.	2	10	56.	6	6	101.	3	9
12.	2	10	57.	6	6	102.	4	8
13.	10	2	58.	12	0	103.	4	8
14.	3	9	59.	9	3	104.	6	6
15.	5	7	60.	4	8	105.	6	6
16.	4	8	61	1	11	106.	5	7
17.	8	4	62.	1	11	107.	5	7
18.	7	5	63.	4	8	108.	3	9
19.	3	9	64.	3	9	109.	3	9
20.	7	5	65.	4	8	110.	9	3
21.	4	8	66.	4	8	111.	8	4
22.	5	7	67.	1	11	112.	7	5
23.	6	6	68.	2	10	113.	4	8
24.	8	4	69.	2	10	114.	6	6
25.	3	9	70.	2	10	115.	6	6
26.	11	1	71.	1	11	116.	1	11
27.	11	1	72.	2	10	117.	1	11
28.	8	4	73.	2	10	118.	1	11
29.	10	2	74.	2	10	119.	4	8
30.	10	2	75.	2	10	120.	6	6
31.	12	0	76.	1	11	121.	5	7
32.	8	4	77.	1	11	122.	3	9
33.	7	5	78.	1	11	123.	4	8
34.	7	5	79.	1	11	124.	6	6
35.	5	7	80.	1	11	125.	5	7
36.	4	8	81.	3	8	126.	5	7
37.	10	2	82.	3	8	127.	7	5
38.	5	7	83.	3	8	128.	4	8
39.	5	7	84.	4	8	129.	4	8
40.	4	8	85.	4	8	130.	2	10
41.	3	9	86.	7	5	131.	2	10
42.	3	9	87.	4	8	132.	7	5
43.	4	8	88.	7	5	133.	3	9
44.	4	8	89.	6	6	134.	5	7
45.	9	3	90.	6	6	135.	7	5

ITEM ANALYSIS OF EXIT MATH COMPETENCIES FOR ELECTRICITY (N=12)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
136.	2	10	139.	3	9	141.	2	10
137.	1	11	140.	4	8	142.	1	11
138.	2	10						

ITEM ANALYSIS OF EXIT MATH COMPETENCIES FOR ELECTRONICS (N-14)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	14	0	46.	14	0	91.	14	0
2.	14	0	47.	11	3	92.	14	0
3.	14	0	48.	11	3	93.	14	0
4.	13	1	49.	13	1	94.	13	1
5.	13	1	50.	14	0	95.	14	0
6.	11	3	51.	14	0	96.	14	0
7.	14	0	52.	13	1	97.	14	0
8.	14	0	53.	12	2	98.	14	0
9.	14	0	54.	10	4	99.	13	1
10.	12	2	55.	10	4	100.	12	2
11.	10	4	56.	10	4	101.	12	2
12.	9	5	57.	10	4	102.	13	1
13.	11	3	58.	14	0	103.	12	2
14.	9	5	59.	14	0	104.	13	1
15.	12	2	60.	13	1	105.	13	1
16.	9	5	61.	12	2	106.	12	2
17.	14	0	62.	11	3	107.	12	2
18.	13	1	63.	13	1	108.	11	3
19.	12	2	64.	11	3	109.	11	3
20.	13	1	65.	14	0	110.	14	0
21.	11	3	66.	13	1	111.	14	0
22.	10	4	67.	13	1	112.	14	0
23.	8	6	68.	11	3	113.	13	1
24.	14	0	69.	11	3	114.	14	0
25.	14	0	70.	10	4	115.	14	0
26.	14	0	71.	9	5	116.	11	3
27.	14	0	72.	10	4	117.	11	3
28.	14	0	73.	11	3	118.	11	3
29.	14	0	74.	8	6	119.	13	1
30.	14	0	75.	5	9	120.	14	0
31.	14	0	76.	8	6	121.	14	0
32.	13	1	77.	8	6	122.	14	0
33.	11	3	78.	10	4	123.	14	0
34.	11	3	79.	14	0	124.	14	0
35.	11	3	80.	14	0	125.	14	0
36.	9	5	81.	8	6	126.	14	0
37.	14	0	82.	9	5	127.	14	0
38.	11	3	83.	8	6	128.	13	1
39.	12	2	84.	12	2	129.	13	1
40.	8	6	85.	12	2	130.	12	1
41.	13	1	86.	14	0	131.	14	0
42.	13	1	87.	12	2	132.	14	0
43.	13	1	88.	14	0	133.	14	0
44.	11	3	89.	14	0	134.	14	0
45.	13	1	90.	13	1	135.	14	0

Item Analysis of Exit Math Competencies for Electronics (N=14) (continued)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
136.	14	0	139.	14	0	141.	14	0
137.	14	0	140.	14	0	142.	14	0
138.	14	0						

ITEM ANALYSIS OF EXIT MATH COMPETENCIES FOR MACHINE SHOP (N=11)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	9	2	41.	4	7	81.	11	0
2.	5	6	42.	5	6	82.	11	0
3.	5	6	43.	3	8	83.	11	0
4.	4	7	44.	4	7	84.	11	0
5.	6	5	45.	10	1	85.	11	0
6.	2	9	46.	11	0	86.	11	0
7.	5	6	47.	11	0	87.	11	0
8.	5	6	48.	8	3	88.	11	0
9.	10	1	49.	11	0	89.	11	0
10.	11	0	50.	11	0	90.	11	0
11.	5	6	51.	11	0	91.	11	0
12.	4	7	52.	5	6	92.	10	1
13.	6	5	53.	11	0	93.	11	0
14.	2	9	54.	5	6	94.	11	0
15.	4	7	55.	7	5	95.	11	0
16.	3	8	56.	4	7	96.	11	0
17.	4	7	57.	6	5	97.	10	1
18.	4	7	58.	11	0	98.	11	0
19.	3	8	59.	3	8	99.	11	0
20.	2	9	60.	0	11	100.	11	0
21.	3	8	61.	11	0	101.	11	0
22.	5	6	62.	0	11	102.	11	0
23.	5	6	63.	0	11	103.	11	0
24.	7	4	64.	0	11	104.	10	1
25.	7	4	65.	0	11	105.	11	0
26.	9	2	66.	0	11	106.	10	1
27.	7	4	67.	1	10	107.	11	0
28.	7	4	68.	1	10	108.	11	0
29.	7	4	69.	1	10	109.	11	0
30.	6	5	70.	1	10	110.	10	1
31.	7	4	71.	1	10	111.	11	0
32.	7	4	72.	1	10	112.	11	0
33.	4	7	73.	1	10	113.	11	0
34.	4	7	74.	1	10	114.	10	0
35.	4	7	75.	1	10	115.	11	0
36.	2	9	76.	0	11	116.	8	3
37.	7	4	77.	0	11	117.	9	2
38.	2	9	78.	10	1	118.	10	1
39.	4	7	79.	11	0	119.	11	0
40.	1	10	80.	11	0	120.	11	0

Appendix S

Competencies not selected by Vocational Instructors

Common Math Competencies Not Selected for Drafting, Electricity, Electronics, Machine Shop (N = 50)

4. Represent trigometric functions by graphing.
6. Solve two simultaneous equations by graphing.
8. Add, subtract, multiply and divide positive and negative powers of ten.
11. Square a monomial.
12. Cube a monomial.
13. Take the square root of a monomial.
14. Find the cube root of a monomial.
15. Square a binomial.
16. Take the square root of a trinomial.
17. Multiply and divide numbers with exponents.
18. Multiply a number with an exponent by an exponent.
19. Multiply a fraction with an exponent by an exponent.
20. Express numbers with negative exponents as numbers with positive exponents.
21. Find the values of numbers with fractional exponents.
22. Simplify radicals containing fractions.
23. Add and subtract radicals.
25. Determine signs in a complex equation.
31. Solve a problem using a formula with knowns and one unknown expressed in the same unit.
32. Solve a problem involving 2 formulas, 3 or more knowns, and one unknown.
33. Solve a problem involving 3 formulas, 3 or more knowns, and one or more unknown.
34. Solve a quadradic equation.
35. Solve equations with the quadradic formula.
36. Solve quadradic equations by graphing.
37. Factor a simple equation.
38. Find the prime factors of equations.
39. Find the product wiyh the difference and sum of two equations.
40. Factor the sum and difference of 2 cubes.
41. Solve simultaneous linear equations by addition and subtraction.
42. Solve simultaneous linear equations by substitution.
43. Solve simultaneous equations by comparison.
44. Solve fractional for simultaneous equations.
52. Solve graphically for elements of a right triangle.
54. Find the least common multiple.
55. Reduce a fraction to its lowest term.
56. Change sign of fractions.
57. Add, subtract, multiply and divide frations.
59. Set up equations from theory.
60. Express equations in logarithmic form.
61. Find the lofarithm of a product.
62. Find the logarithm of a quotient.
63. Find the logarithm of a power.
64. Find the logarithm of a root.

65. Find the logarithm of a number.
66. Express equations in exponential form.
67. Find the antilog of a number.
68. Add logarithms.
69. Subtract logarithms.
70. Multiply logarithms.
71. Compute logarithms with negative numbers.
72. Division by logarithms.
73. Multiplication and division by logarithms.
74. Extracting roots by logarithms.
75. Compute equations using logarithms with fractional exponents.
76. Graph a logarithm function.
77. Solve a logarithmic equation.

Competencies Not Selected For Drafting (N = 12)

List the side and or angle relationships for the following :

103. Nonagon.
104. Decagon.
105. Dodecagon.
106. Tetrahedron.
107. Hexahedron.
108. Octahedron.
109. Dodecahedron.
110. Icosohedron.
113. Right triangular prism.
114. Right rectangular prism.
115. Right pentagonal prism.
116. Oblique pentagonal prism.
117. Oblique hexagonal prism.
119. Oblique circular cylinder.
120. Right triangular pyramid.
121. Right square pyramid.
122. Oblique pentagonal pyramid.
123. Right circular cone.
124. Oblique circular cone.
125. Sphere.
126. Torus.

Competencies Not Selected For Electricity (N = 12)

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2. Represent the products of two numbers on a graph.
3. Find the value of a radius vector graphically.
5. Determine x and y intercepts on a graph.
24. Group terms in an equation.
28. Solve an equation by canceling a term.

48. Find functions of an angle in second, third, and fourth

quadrants.
50. Find trigometric ratios of angles of right triangles.
78. Solve electronic problems using logarithms.
79. Express gain or loss of apparatus in decibels.
80. Express gain or loss of quantities in decibels.
81. Find the inductanc of a line using logarithms.
82. Find the impedance of a line using logarithms.
83. Find the capacitance of a line using logarithms.
84. Graph the equation y = sin x.
85. Graph the cosine curve.
86. In equations of periodic curves, specify frequency.
87. In equations of periodic curves, specify angle of velocity.
88. In equations of periodic curves, specify the amplitude.
89. In equations of periodic curves, specify period.
90. In equations of periodic curves, specify angle of lead or lag.
99. Determine angles in a vector diagram and plot imaginary numbers on a vector diagram.
100. Express ac circuit parameters in polar form.
101. Convert ac circuit parameters from rectangular to polar form and vice versa.
102. Solve problems using parameters expressed in rectangular.
103. Solve problems using parameters expressed in polar form.
104. Add vectors in rectangular form.
105. Subtract vectors in rectangular form.
106. Multiply vectors in rectangular form.
107. Divide vectors in rectangular form.
108. Multiply polar vectors.
109. Divide polar vectors.
111. Construct and analyze truth tables.
112. Develop a Boolean equation from a logic diagram.
113. Use the sum of products mehtod to solve a Boolean equation.
114. Develop a sum-of-products equation from a truth table.
115. Simplify a Boolean equation.
116. Convert a truth table into a Karnough map.
117. Draw a three and four variable Karnough map from a truth table.
118. Simplify a Karnough map by using octets, quads, or pairs.
119. Use the product of sums method to simplify a truth table.
120. Convert a truth table to an equation.
121. Simplify a product of sums equation.
122. Use multiplexer logic.
123. Find BCD equivalents of decimal numbers.
124. Convert binary numbers to decimal equivalents.
125. Convert octal numbers to decimal equivalents.
126. Find the decimal equivalent of an octal number.
127. Convert hexadecimal numbers to binary numbers.
128. Express a decimal number in excess - 3 code.
129. Express an excess - 3 number as a decimal equivalent.

130. Convert Gray numbers to decimal equivalent.
131. Give the sum of numbers in base 8 or 16.
132. Sum of binary numbers.
133. Add whole numbers in base 10 using 16 bit numbers.
134. Subtract binary numbers.
135. Subtract whole numbers in the base ten system.
136. Determine overflow of problems with 8 bit unsigned arithmetic.
137. Express positive or negative whole numbers in 8 bit sign magnitude form.
138. Convert sign magnitude numbers into decimal equivalents.
139. Express the complement of numbers in hexadecimal notation.
140. Express the 2's complement of binary numbers.
141. Convert positive or negative whole numbers to 2's complement representation.
142. Show the 8 bit addition and subtraction of decimal numbers in 2's complement representation.

Competencies Not Needed For Electronics (N = 14)

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80. Express gain or loss of quantities in decibels.
81. Find the inductance of a line using logarithms.
82. Find the impedance of a line using logarithms.
83. Find the capacitance of a line using logarithms.

Competencies Not Selected For Machine Shop (N = 11)

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2. Represent the products of two numbers on a graph.
3. Find the value ofa radius vector graphically.
5. Determine x and y intercepts on a graph.
7. Convert a whole number to a positive power of ten.
24. Group terms in an equation.
27. Solve equations by transposing.
28. Solve an equation by canceling a term.
29. Check solutions for equations.
30. Form equations from observed data.

Appendix 6

Additional Competencies Submitted by Instructors

ADDITIONAL COMPETENCIES SUPPLIED BY VOCATIONAL INSTRUCTORS

ADDITIONAL COMPETENCIES IN DRAFTING

1. Calculator algebra.
2. Calculator trigonometry and scientific notation.
3. Reading a micrometer.
4. Computer aided drafting.
5. Use architects', metric, civil, and mechanical engineer's scales.
6. Use precision measuring instruments.
7. Calculate force.
8. Construct hyperbolas and parabolas.
9. Construct the focielinse.
10. Construct the parallelogram ellipse.
11. Construct the helix.
12. Compute surface or rim speed.
13. Compute the area of a sector.
14. Bisect or find the middle point of a line.
15. Bisect an angle.
16. Bisect an arc.
17. Erect a perpendicular.
18. Geometrically construct parallel lines.
19. Calculate vector algebra.

ADDITIONAL COMPETENCIES IN ELECTRICITY

1. Calculator --algebra
2. Calculator--trigonometry and scientific notation
3. Graphing electrical quantities.

ADDITIONAL COMPETENCIES IN ELECTRONICS

1. Determinants.

Appendix 7

Publishing Companies Contacted

PUBLISHING COMPANIES CONTACTED FOR MATH TEXTS AND RESOURCES

Delmar Publishers Inc.
2 Computer Drive. West
Box 15015
Albany, New York 12212-5015

Teaching Aids Incorporated
Post Office Box 1798
Costa Mesa, California 92628-0798

Curriculum Instructional Materials Center
1500 West Seventh
Stillwater. Oklahoma 74074-4364

American Technical Publishers Inc.
12235 S. Laramie Ave.
Alsip, Illinois 60658

National Innovative Media Company
Route 2 Box 301 B
Calhoun, Kentucky 42327

McGraw Hill Book Company
Educational Publishing and Training Group
Manchester Road
Manchester, Missouri 63011

DRW Company
ABRAXAS Films Division
P.O. Box 2941
Costa Mesa, California 92628-2941

Goodheart-Willcox Company, Inc.
123 W. Taft Dr.
South Holland, Illinois 60473